Appendix H

SCAQMD Source Test Report Foss Plating, Santa Fe Springs, California

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SOURCE TEST REPORT

98-112

Conducted at

Foss Plating Company 8140 Secura Way Santa Fe Springs, CA 90670

NICKEL EMISSIONS FROM A SEMI-BRIGHT NICKEL ELECTROPLATING TANK WITH AND WITHOUT AIR AGITATION

TESTED:

October 24 -25, 1998

ISSUED:

December 30, 1998

REPORTED BY:

Michael Garibay

Air Quality Engineer II

REVIEWED BY:

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Senior Air Quality Engineer

MONITORING AND ENGINEERING BRANCH

MONITORING AND ANALYSIS DIVISION

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BACKGROUND

a. Firm	. Foss Plating Company
b. Test Location	8140 Secura Way, Santa Fe Springs, CA 90670
c. Unit Tested	.Semi-Bright Nickel Electroplating Tank
d. Test Requested by	Jill Whynot, Stationary Source Compliance, (SSC) (909)396-3104
e. Reason for Test Request	Develop Emission Factors for Rule 1401
f. Dates of Test	. October 24, & 25,1998
g. Source Test Performed by	E. Ramirez M. Garibay, G. Kasai, C. Willoughby
h. Test Arrangements Made Through	Carol Foss-McCracken (562) 945-3451 Paul Huffman (562) 945-3451
i. Source Test Observed by	Victor Foss, (562) 945-3451 Hugh Brown, Pacific Environmental Services, Inc. (PES) (626) 856-1400

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RESULTS

Nickel Emissions from a Semi-Bright Nickel Electroplating Tank - with Air Agitation

Run #	lb/(hr-scfm _{air})	lb/(hr-ft² _{tank})	lb/(hr-ft ² _{parts})	mg/dscm	mg/(A-hr)
1	2.04 x 10 ⁻⁵	1.06 x 10 ⁻⁵	9.43 x 10 ⁻⁶	0.622	0.214
2	2.46 x 10 ⁻⁵	1.28 x 10 ⁻⁵	1.14 x 10 ⁻⁵	0.721	No Plating
Average	2.25 x 10 ⁻⁵	1.17 x 10 ⁻⁵	1.04 x 10 ⁻⁵	0.672	[*] 0.214
Workplace Background	-	-	-	0.050	-

Nickel Emissions from a Semi-Bright Nickel Electroplating Tank - No Air Agitation

Run#	lb/hr	lb/(hr-ft² _{tank})	lb/(hr-ft ² _{parts})	mg/dscm	mg/(A-hr)
1	1.62 x 10 ⁻³	1.69 x 10 ⁻⁵	1.50 x 10 ⁻⁵	0.99	0.340
2	1.90 x 10 ⁻³	1.98 x 10 ⁻⁵	1.76 x 10 ⁻⁵	1.13	0.399
Average	1.76 x 10 ⁻³	1.83 x 10 ⁻⁵	1.63 x 10 ⁻⁵	1.06	0.369
Workplace Background	-	-	•	5.33 x 10 ⁻³	-

Note: See PROCESS DESCRIPTION and CONCLUSION sections for issues relating to operating conditions during testing.

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<u>INTRODUCTION</u>

The South Coast Air Quality Management District (SCAQMD), is attempting to gather information on emissions from plating and metal treating processing from nickel plating facilities. The testing was requested to provide improved data on emissions from these operations and address unresolved issues under SCAQMD Rule 1401. The results of the testing are intended to be used as emissions factors in health risk exposure assessments.

Previous testing conducted by the Metal Finishing Association of Southern California (MFASC) and the California Air Resources Board (CARB) consisted of triplicate tests for nickel from nickel electroplating. Issues were raised during the review of the MFASC test regarding high levels of background nickel and potential fugitive losses. The scope of the testing was later expanded during an SCAQMD effort to measure nickel emissions from electroless nickel plating operations, hydrogen chloride from metal acid treating tanks and sodium hydroxide from metal treating tanks at nickel plating facilities. The complete SCAQMD testing series in the project consists of SCAQMD Source Tests: 98-105, 98-106, 98-107, 98-108, 98-109, 98-110, 98-111, and 98-112.

The test plan for the SCAQMD testing was developed via a cooperative effort with the MFASC. This test report incorporates and addresses comments from representatives from both the SCAQMD and MFASC during weekly meetings from the project's beginning to end. The testing was conducted at a volunteer MFASC member facility. The sampling was conducted by SCAQMD Methods and Testing staff. The analysis was conducted by the SCAQMD laboratory and SCAQMD contractor.

This source test was designed to address issues raised during both the MFASC and SCAQMD previous testing efforts. The facility and tank were selected for testing by the MFASC. Since the past MFASC testing was also conducted at this facility, it was thought that a comparison could be made to the existing data. The tank was also selected due to MFASC concerns from the past SCAQMD test that the relatively small (3' x 5') host tank may not be representative of larger tank emissions. Validity concerns regarding testing approach raised during the past testing are addressed in the approach employed in the current test effort.

The current test consists of two sets of duplicate two hour sampling runs with one set run operating without air agitation and the second set run with the air agitation. The results are reported in various units.

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PROCESS DESCRIPTION

Background

In the plating industry, nickel plating is employed as a decorative and/or protective layer over a variety of metal pieces. The nickel plating can be used as a final finish or covered with a thin plating of chromium as with decorative chrome applications. The nickel plating can be conducted using electrodes and electromotive force or using an electroless process. Emissions are produced as small droplets of the solution in aerosol form due to bubbling in the tanks caused by electrolysis or other processes such as air agitation commonly employed to enhance the plating process.

In the electrolytic plating process, the parts are immersed in an acidic solution with ionic nickel where a current is applied so that solid nickel is plated onto the parts. An immersion heater can be employed in the plating tanks to maintain a desired plating bath temperature. This type of plating employs a surface tension reducing agent to reduce the surface tension to approximately 35 dynes/cm for purposes of minimizing pitting in the plating process. The solutions within the tanks are agitated by pump recirculation and/or by bubbling with air. Either a bright or semi-bright plated finish can be accomplished depending on the additives in the plating solution. The tanks are equipped with rectifiers to produce a low voltage high amperage DC current. According to the Lawrence J. Durney, Electroplating Engineering Handbook, the metal parts are plated with a current density of 20 - 50 amperes per square foot of plating surface area. The majority of the existing nickel electroplating tanks are not vented by a dedicated ventilation system. The buildings that house these processes, typically employ some type of ventilation system which may be forced draft, natural draft, or cross draft in nature.

For the electroless nickel plating, the plating is driven by difference in electropotential. The solution differs from the electroplating solution to enhance this process. For electroless applications, since the solutions contain odiferous compounds such as ammonia, the plating tanks typically include ventilation systems at a close proximity above the plating tanks to draw emissions from the plating tanks out of the work space.

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The nickel platers also employ both hydrochloric acid and sodium hydroxide metal treating processes. The hydrochloric acid process is an etching process in which bubbling occurs due to gasses produced as the metal is etched. The sodium hydroxide process can be employed in by spraying, electrocleaning, etching (for aluminum), or soak cleaning with a detergent. Of the sodium hydroxide processes, the soak cleaning is expected to produce the least amount of emissions, while the spraying is expected to produce the highest.

Nickel Plating Operation During Testing

During testing, the nickel electroplating tank was operated during active plating for the entire test period. Unlike either of the past testing efforts, the parts were not removed to simulate drag-out effects. This was done both because of the difficulty of removing parts with the test hood in place and the belief that the drag-out process does not significantly affect emissions. Steel dummy parts were used as a plating substrate as shown in Figure 1. The number of dummy parts was selected by the facility as representative of normal operation of the host tank. The parts were then measured for surface area and a plating amperage was selected for a plating current density of exactly 20 amperes per square foot. This current density was chosen as to be as consistent as possible with the past MFASC testing current density of 17 amperes per square foot while also remaining within the range of normal nickel plating as specified in the Electroplating Engineering Handbook. The chosen current density was also verified by discussion with the MFASC to be appropriate for representing typical nickel plating. The parts were submerged entirely in the plating solution.

The actual applied current density was calculated using the surface area of the dummy parts. The tank was equipped with a circulation pump and filter system. During normal operation, the circulation pump discharges the solution above the level in the tank which was observed to produce a certain amount of splashing. During the non-air agitated tests, the discharge was extended to below the level of the tank so that the splashing in the tank would not affect the measurement of emissions from the plating. To achieve normal operation under the air agitated condition, the discharge was maintained above the level in the tank. Photographs of the host plating tank and the surface of the solution both with and without air agitation are shown in Figures 2 through 7. The following are the specifications of the nickel plating tank and the lists of operating conditions that were monitored during the each of the test runs:

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Tank Dimensions	Type of Plating
96"W x 120"L x 63"H	Semi-Bright Nickel

Operating Conditions Recorded During Testing - Air Agitation Run #1

Freeboard Height	4.0	inches
Plating Solution Temperature	139-1	42 °F
Plating Solution Nickel Content	5.85	oz/gal
Plating Solution Nickel Sulfate Content	18.7	oz/gal
Plating Solution Nickel Chloride Content	6.72	oz/gal =
Plating Solution Boric Acid Content	4.03	oz/gal
Plating Solution pH	4.75	pH
Plating Solution Surface Tension	47.0	dynes/cm
Ampere-hour Usage	4827	A-hr
Elapsed Time Between A-hr Readings	2.23	hr
Plating Voltage	9.6	volts ,
Average Amperage Applied	2162	A-hr/hr
Calculated Current Density	20.0	A/ft ²
Number of Dummy Parts	23	channels
Total Surface Area of Plated Parts	108.2	ft ²
Plating Period within Test Run	120	min / test run
Duration of Test Runs	120	min /test run
Capture Efficiency of Ventilation System	100	%
Ventilation Rate	522	acfm
Air Agitation Rate	49.9	scfm
Air Agitation Rate per Unit Solution Surface Area	0.52	scfm/ft ²
Part Agitation Rate	0	in/min
Solution Circulation Rate	40-50	gpm (estimated)
Solution Discharge Location	5"	above surface

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Operating Conditions Recorded During Testing - Air Agitation Run #2

4.1	:1
132-1.	39 °F
5.85	oz/gal
18.7	oz/gal
6.72	oz/gal
4.03	oz/gal
4.75	pH
47.0	dynes/cm
0	A-hr
0	hr
0	volts
0	A-hr/hr
0	A/ft ²
0	channels
0	ft ²
0	min / test run
0	min /test run
100	%
535	acfm
49.9	scfm
0.52	scfm/ft ²
0	in/min
40-50	gpm (estimated)
5"	above surface
	18.7 6.72 4.03 4.75 47.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

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Operating Conditions Recorded During Testing - No Air Agitation Run #1

Freeboard Height	4.1	inches
Plating Solution Temperature	132-1	35 °F
Plating Solution Nickel Content	5.85	oz/gal
Plating Solution Nickel Sulfate Content	18.7	oz/gal
Plating Solution Nickel Chloride Content	6.72	oz/gal
Plating Solution Boric Acid Content	4.03	oz/gal
Plating Solution pH	4.75	pH
Plating Solution Surface Tension	47.0	dynes/cm
Ampere-hour Usage	4792	A-hr
Elapsed Time Between A-hr Readings	2.68	hr
Plating Voltage	9.5	volts
Average Amperage Applied	2159	A-hr/hr
Calculated Current Density	20.0	A/ft²
Number of Dummy Parts	23	channels
Total Surface Area of Plated Parts	108.2	ft ²
Plating Period within Test Run	120	min / test run
Duration of Test Run	120	min /test run
Capture Efficiency of Ventilation System	100	%
Ventilation Rate	489	acfm
Air Agitation Rate	0	scfm
Air Agitation Rate per Unit Solution Surface Area	0	scfm/ft ²
Part Agitation Rate	0	in/min
Solution Circulation Rate	40-50	gpm (estimated)
Solution Discharge Location	5"	below surface

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Operating Conditions Recorded During Testing - No Air Agitation Run #2

Freeboard Height	4.2	inches
Plating Solution Temperature	136-14	10 °F
Plating Solution Nickel Content	5.85	oz/gal
Plating Solution Nickel Sulfate Content	18.7	oz/gal
Plating Solution Nickel Chloride Content	6.72	oz/gal
Plating Solution Boric Acid Content	4.03	oz/gal
Plating Solution pH	4.75	pΗ
Plating Solution Surface Tension	47.0	dynes/cm
Ampere-hour Usage	4181	A-hr
Elapsed Time Between A-hr Readings	1.93	hr
Plating Voltage	9.6	volts
Average Amperage Applied	2162	A-hr/hr
Calculated Current Density	20.0	A/ft ²
Number of Dummy Parts	23	channels
Total Surface Area of Plated Parts	108.2	
Plating Period within Test Run	120	min / test run
Duration of Test Run	120	min /test run
Capture Efficiency of Ventilation System	100	%
Ventilation Rate	517	acfm
Air Agitation Rate	0	scfm
Air Agitation Rate per Unit Solution Surface Area	0	scfm/ft ²
Part Agitation Rate	0	in/min
Solution Circulation Rate		gpm (estimated)
Solution Discharge Location	5"	below surface

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TESTING METHODOLOGY

The testing consisted of two sets of duplicate two hour sampling runs with one set run under the air agitation operating condition and the second set run without the air agitation. The applied amperage during plating was obtained from a calibrated amp-hour meter and the elapsed time. The amp-hour meter was calibrated by Atlas Testing Laboratories on May 13, 1998.

A temporary reduced draft ventilation system was designed and constructed both to isolate the process and collect the resulting nickel emissions in a manner to both facilitate the emissions measurement and to address concerns by the MFASC. The main MFASC concern was that a high flow ventilation system, such as a dedicated side-draft ventilation system may produce higher emissions due to entrainment of large splashed droplets that potentially fall back into the tanks or to the ground and may not become emissions to the atmosphere.

The temporary reduced draft system was designed to simulate emissions to the atmosphere of an unventilated tank. Mass emissions collected in the duct of a ventilated tank may be higher due to this effect. The temporary ventilation system consisted of 40"L x 40"W x 56"H hood suspended at a distance of 8 inches above the solution surface in the center of the host tank. The hood was vented to a small blower which was set to achieve a specific velocity vertically through the hood. The height of the hood was 1.4 times the equivalent diameter of its base. A straight run of ducting between the hood and the blower was used to isolate and measure the emissions from the tank.

Clear plastic sheets were used to cover the uncovered portion of the host tank. The plastic was also suspended at a height of 8 inches above the solution surface. Two openings of approximately 8 inches wide were left at either of the shorter 8 ft. sides of the tank to allow air to enter the space above the tank. The hood and tank cover vent system operated as follows: The air entered at both of short ends of the tank and swept across the space between the tank and cover at a specified velocity. The air then flowed into the hood and traveled upwards through the hood at the specified velocity. Both the hood and the space above the tank acted as a settling zone where larger droplets that would normally not be carried away from the tank are allowed to fall back into the tank. By using a hood that has a smaller cross section than the tank, a lower dilution air rate



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can be employed. The use of this lower dilution air rate has the advantage of increasing the concentration in the duct which results in a lower relative error in the emission measurement. The approach also has the advantage of making the effects of contamination such as that in the ambient air to be much less significant as compared to that experienced in the past MFASC test. A schematic of this emissions capture system is shown in Figure 8. A photograph of the hood connected to the host tank is shown in Figure 9.

The appropriateness of the hood height was determined by a small scale 16"W x 20"L x 25"H hood connected to a small blower to simulate the full scale design. At a ventilation rate of 50 ft/min as determined by a calibrated vane anemometer, the height of the hood was sufficient to create a uniform velocity over the lower cross-section of the hood and maintain this uniformity for the lower one third of the hood. This was done to ensure that no high or low velocity zones were present as to defeat the purpose of the hood in its lower section.

As discussed in meetings with SCAQMD Methods and Testing staff and MFASC, the specific velocity was chosen to be approximately 50 ft/min. This specific velocity was chosen for the following reasons:

- 1. The velocity is considered as the minimum velocity at which 100% capture of actual emissions to the atmosphere can be achieved. This was verified using the small scale capture hood and a smoke test.
- 2. The velocity is sufficiently low as to not overestimate the range of velocities that may be encountered in a building that houses the process. This is important since these internal air currents are responsible for transporting the emissions to the atmosphere. For purposes of comparison, 50 ft/min equates to 0.57 miles per hour. Assuming that outdoor wind speeds typically vary from 3 -10 mph, it is not unreasonable to assume that 0.57 mph indoor air movements can be induced either by open doors, or the building's ventilation system.
- 3. According to the American Conference of Governmental Industrial Hygienist Industrial Ventilation Manual, 50 fpm is the indoor air speed created by an effective air conditioning system.



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- 4. Calculations of settling velocity of small aerosols shows that small aerosol droplets less than 10 microns in diameter are capable of remaining airborne for several minutes, and much longer in moving air.
- 5. Past testing for cadmium emission factor has been successfully employed using a similar capture velocity.

Two large doors on the west side of the building provided a limited supply of outside air to the building. This air flow path in the building was studied by smoke test. The air in the building was observed to enter through the doors and exit through the roof vents above the tank area. The space immediately above the tank area, however, was observed to be stagnant. The exhaust from the hood was directed into the path of the air flowing through the building so that the nickel was swept from the building to avoid the affects of hood exhaust recirculation.

The sampling was conducted on a weekend so that background nickel in the building was allowed to either ventilate or settle out of the building air overnight. The non-air agitation tests were conducted before the air agitation tests to minimize the amount of background nickel present both in the air and in the collection equipment during the non-air agitated test.

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SAMPLING AND ANALYTICAL PROCEDURES

Flow Rate

The gas velocity within the sampling duct was measured during each sampling run at eight points within the duct cross section as according to SCAQMD Methods 1.2 and 2.3. This was performed simultaneously with the pollutant sampling using a NIST traceable standard type Pitot tube with a differential pressure manometer, and a type "K" thermocouple with a potentiometer (Figure 10). The apparatus was checked for leaks both before and after use by introducing a pressure head and blocking the flow at the Pitot tip. An observation of the resulting stabilization in pressure at the manometer verified the absence of leaks in the system. The stack's access ports were located using the approach of SCAQMD Method 2.3 for ducts of less than 12 inches in diameter. Using this approach, the sampling access ports were located approximately eight stack diameters downstream and greater than two stack diameters upstream from flow disturbances. The velocity access ports were located approximately five stack diameters downstream from the sampling access ports and greater than two stack diameters upstream from a flow disturbance. This configuration meets the minimum and most of the preferred SCAQMD Method 1.2 requirements for measurement site location.

A cyclonic flow check was also performed to check for the presence of flow that is non-parallel to the duct wall which can cause a bias in the flow measurement. This was accomplished by rotating an S-type Pitot tube at each traverse point until a zero pressure differential results at the gauge. The null angle is determined with an inclinometer as the deviation of the Pitot angle with respect to a plane perpendicular to the theoretically straight duct flow. Data from the cyclonic flow check shows that the duct does not exhibit cyclonic flow as defined in Method 1.1.

The volumetric flow rate was calculated for each sampling run using the stack's cross sectional area and average gas velocity. The flow rate was corrected to standard conditions by using the stack temperature and pressure along with the barometric pressure measured with a calibrated aneroid barometer. The flow rate was also corrected to dry conditions using the moisture content as determined by the SCAQMD Method 4.1 weight gain from the nickel sampling train as described in the following section.

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Nickel Sampling - Modified CARB Method 433

A nickel sample was collected during each sampling run using Modified CARB Method 433. The modification was the same as that employed by MFASC contractor, PES, which consists of the use of a back-up filter as opposed to the up-front heated filter.

The sample was collected from the locations within the sampling duct previously described in the velocity measurements. Each sample was collected over a period of 120 minutes using a sampling train consisting of a glass probe and nozzle connected by a four foot length of non-reactive tubing to the first of two Greenburg-Smith impingers each containing 100 ml of 0.1N nitric acid solution, an empty bubbler, a 0.5 micron glass fiber back-up filter, and a bubbler containing tared silica gel desiccant.

The impinger assembly was connected to a vacuum pump and a calibrated dry gas meter as shown in Figure 11. The sampling apparatus was checked for leaks both before and after sampling by blocking the flow at the probe tip. An observation of the resulting decrease in flow at the meter to less than 0.02 cfm or four percent of the sampling rate indicated an acceptable leak rate. The impinger train was contained within an ice bath to condense water and other condensable matter present in the sample stream.

The impinger train was returned to the SCAQMD laboratory for recovery. The recovered solutions were dissolved in concentrated nitric acid and boiled down according to CARB Method 433 and sent to West Coast Analytical Service, Inc. for analysis. Nickel collected in the nozzle, probe, impingers, and filter was determined using CARB Method 433 by Inductively Coupled Plasma Mass Spectrometry (ICPMS).

At the request of the MFASC, workplace background sampling within the plating facility was conducted. The workplace background samples were collected using the same configuration and analysis as that used for emissions sampling. The samples were collected at a distance of approximately three feet from the plating tank in the upwind direction with respect to airflow in the building at approximately the same height that the air entered the collection hood. The first workplace background sample represents composite sampling of the facility air during the non-air agitation runs. The second workplace background sample represents composite sampling of the facility air during the air agitation runs. A blank field sample train was also analyzed as above for quality control purposes.

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Capture Efficiency

The capture efficiency was determined by a smoke test. The smoke test was accomplished using titanium chloride smoke generating tubes. This technique can be used to verify 100% capture or conversely less than 100% capture by observing the flow of the smoke into the capture hood. The observation of complete capture of the smoke indicated 100% capture efficiency. The smoke test was conducted at both of the open ends of the tank between the temporary capture sheets and the tank. Photographs of the actual smoke test are shown in Figure 12.

The height of the capture hood and the ventilation rates were adjusted in an attempt to achieve the 50 ft/min specified velocity vertically within the hood as well as horizontally across the tank. The actual velocities achieved during each sampling run were calculated from the ventilation flow rate and the cross sectional areas. The results of these calculations are presented in the following table:

Run #	Vent Velocity (fps)	Vertical Velocity in Hood (fpm)	Horizontal Velocity Between Hood and Tank (fpm)
Run #1 with Air	32.56	47.5	49.4
Run #2 with Air	33.34	48.6	50.6
Run #1 no Air	30.49	44.5	46.3
Run #2 no Air	32.23	47.0	48.9

Where:

Vent Cross Section (7.0" diameter) = 0.267 ft^2

Hood Cross Section (40" x 40")= 11.11 ft^2

Gap Cross Section (8.0" avg. between cover and solution from both 8 ft. ends) = 10.67 ft^2 Vent Velocity is taken from the flow rate calculations

Vertical Velocity = Vent Velocity x 60 s/min x Vent Cross Section / Hood Cross Section Horizontal Velocity = Vent Vel. x 60 s/min x Vent Cross Section / Gap Cross Section

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Air Agitation Rate

To measure the air agitation rate, a five gallon plastic bucket was inverted and submerged to approximately one third of its height into the plating solution to create an air-tight seal at the bucket's perimeter. The bucket was moved across the surface of plating bath as to encompass the average air agitation rate in the tank while maintaining the bucket at a constant submersion height. A tap on the unsubmerged side of the bucket was connected to a calibrated gas meter to measure the volume of air collected in the bucket during which the elapsed time was also recorded. This technique was checked for accuracy in the laboratory by bubbling a known amount of air into the bottom of a water bath. The bucket technique was successful in duplicating the measurement of the gas metered into the bottom of the tank.

The air agitation rate as determined by this method was reported in units of scfm. Since a 60 °F temperature compensated meter was used at atmospheric pressure, the readings were taken at very close to standard conditions. The moisture in the tank was, for the most part, condensed in the line between the bucket and the meter. A residual moisture, however, of approximately 2 - 5% remained in the metered air as it passed through the line. For this reason, the air agitation rate was not reported as a dry flow rate.

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TEST CRITIQUE

An effort was made to duplicate the operating conditions of the past MFASC testing to the extent possible. A comparison of the key operational parameters recorded during testing to the past MFASC testing, as well as the past SCAQMD testing is shown in the table below.

Comparison of Key Operation Parameters for the Recent Nickel Plating Tests

Process Parameter	MFASC Test Foss	SCAQMD Test at	SCAQMD Test at
		Foss	California Technical
Plating Current	17 amperes/ft ² parts	20 amperes/ft ² parts	23 amperes/ft ² parts
Density			
	not able to	0.52 acfm/ft ² tank	- a ±
Air Agitation Rate	determine	not adjusted from	0.87 acfm/ft ² tank
	accurately	time of MFASC test	
Plating Solution	137-145 °F	132-142 °F	119-124 °F
Temperature			
Plating Solution	10.3 - 12.6 oz/gal	5.9 oz/gal	10.4 oz/gal
Nickel Content			
Plating Solution	5.8 - 8.3 oz/gal	4.0 oz/gal	7.6 oz/gal
Boric Acid Content			
Plating Solution pH	3.4 - 4.3	4.8	2.0
Plating Solution	34.2 - 35.9	47.0 dynes/cm	37.9 dynes/cm
Surface Tension	dynes/cm		
Solution	Discharged Above	Below Level wo/air	Below Level no
Recirculation	'Solution Level	Above w/air	Bubbling
Number of Drag-	6	0	6
Out Events per Run			
	High Dilution, High	Low Dilution, Close	Medium Dilution,
Capture Technique	Distance, Low	Proximity, <50	Close Proximity,
	Velocity	ft/min	<50 ft/min
Sampling Technique	SCAQMD M1-2,	SCAQMD M1-2,	SCAQMD M1-2,
	CARB M433	CARB M433	CARB M433
Duration of Test	120 min	120 min	120 min
Runs			

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The emissions for the non-air agitation runs were higher than the emissions with air agitation. It was expected that the air agitation emissions would be higher than the emissions without the agitation due to the agitation effect as well as observations as stated in SCAQMD Source Test #98-109. The non-air agitation test results were an order of magnitude higher than the past SCAQMD and MFASC tests. During discussions, the MFASC indicated that the increase in non-air agitated emissions was likely due to plating with an unusually low nickel solution concentration causing a low plating efficiency and increased bubbling and nickel emissions. A higher surface bubbling rate was observed during testing as compared to the past SCAQMD testing.

The air agitation run with plating was 17% lower than the air agitation run without plating. Furthermore, the two results are considered as within typical run to run variations from each other. This may suggest that during air agitation, the air agitation is the primary mechanism for the emissions and that the air agitation may partially or completely negate the mechanism for plating emissions. The agitation may have the effect of coalescing with the plating bubbling or perhaps forming larger size bubbling on the surface which masks the effect of the smaller plating bubbling but creates an emission characteristic of its own. It is thought that air agitation will typically result in a net increase in emissions since the agitation is inherently active for a longer period of time than the plating, and since plating emissions can be lower depending on the application.

The measured workplace background concentration for the non-air agitated condition was less than one percent of that measured in the capture vent for emissions sampling. The measured workplace background concentration for the air agitated condition was approximately seven percent of that measured in the capture vent for emissions sampling. Although both sets of test runs each began after an overnight period of non-production to minimize background interference, the air agitation background on the second day of testing was significantly higher than the non-air agitation test. This increase was due primarily to the presence of another nickel tank in the area of the host tank. During the non-air agitation test, this nearby tank did not have a significant effect on the testing since it was not in production during the test period. During the air agitation tests, however, the air agitation in the nearby tank was active. The reason for this was due to the facility's inability to run only one tank with agitation and also to avoid non-normal operation of the host tank. The workplace background samples were positioned in the air steam between the two tanks so that potential contamination would be detected.



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Although the air agitation workplace background was significantly higher than that of the non-air agitation test, both are considered as having a very low significance on affecting the emissions measured in this source test.

The blank sample detection was less than one percent of that detected in the emissions samples. The contribution of the blank is therefore considered as having a very low significance on affecting the emissions measured in this source test.

The precision of the sampling as indicated by the consistency of the duplicate sampling results is well within that which is generally experienced and considered acceptable for this type of sampling.

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CONCLUSION

The results of the test are considered as both sufficiently accurate and precise for use in determining nickel emission factors. The representativeness of the operating conditions, however, of this or the other tests, is considered as out of the scope of the test reports. This report is limited to the presentation of the data, the operating conditions, observations, and limited comments on typical operation. The selection of the various test results that are considered as typical or suitable for developing an emission factor will also be left to discussion beyond the presentation of the data in the source test reports.

During discussions, the MFASC indicated that the increase in non-air agitated emissions from this test, was likely due to plating with an unusually low nickel solution concentration causing a low plating efficiency resulting in increased bubbling and nickel emissions.

Due to the similarities between emissions with the air agitation run with plating and the air agitation run without plating, the air agitation may be indicated as the primary mechanism for the emissions. This may also indicate that the air agitation may partially or completely negate the mechanism for plating emissions. Furthermore, because of the presumed independence of the air agitation mechanism, the aforementioned MFASC concern regarding low nickel concentration and low plating efficiency is thought to have much less of an effect on the air agitation tests. For this reason, the air agitation results may be considered as more typical than the non-air agitation results.

Unlike the other tests in this project, a recommendation on the emission factor in which units would best represent actual emissions will not be made for this report. The reason is that, at the time of this report's issue, further discussion is taking place on which of the data from the various test will be used. Some guidance, however, is given as follows:

If the lb/hr-ft²_{tank} factor is used, emissions would be determined by multiplying the factor by ft²_{tank} as determined using the horizontal internal dimensions of a given tank, and also multiplied by the hours of air agitation for emissions during a specified time period. It is suggested that this factor is not well suited for non-air agitation applications due to the mechanism for the emissions being relatively independent of tank surface area.

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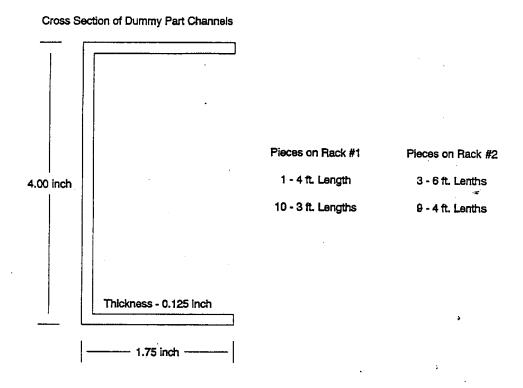
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If the lb/hr-ft²_{parts} factor is used, emissions would be determined by multiplying the factor by ft²_{parts} as determined using the average total surface of parts that are plated in the tank, and also multiplied by the hours of plating during a specified time period. It is suggested that this factor is not well suited for air agitation applications due to the mechanism for the emissions being relatively independent of part surface area.

If the lb/hr-scfmair factor is used, emissions would be determined by multiplying the factor by scfm of air agitation and also multiplied by the hours of air agitation for emissions during a specified time period. If the bucket method is used to determine the air agitation rate, the scfm/ft²tank result would be multiplied by the ft²tank as determined using the horizontal internal dimensions of a given tank to determine scfmair. This factor would not be appropriate for non-air agitation applications.

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Total Length of Pieces = 88 ft.

Total Perimeter of Cross Section = 14.75 ft. = 1.23 ft.

Total Surface Area of Parts = 1.23 ft. x 88 ft. = 108.2 sq. ft.

Figure 1 - Dummy Parts

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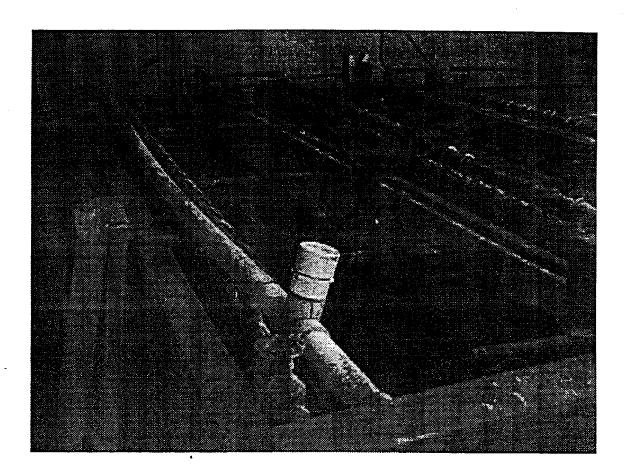


Figure 2 - Photograph of Host Nickel Plating Tank

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Figure 3 - Photograph of Plating Solution Surface with Air Agitation

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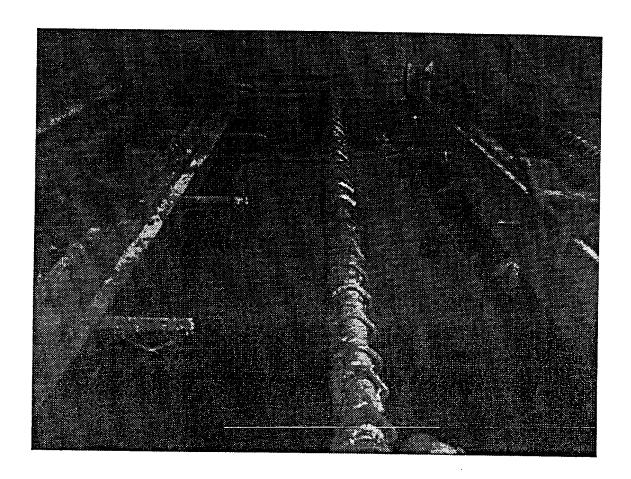


Figure 4 - Photograph of Plating Solution Surface Without Air Agitation

Source Test No. 98-112 .

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Figure 5 - Close-Up Photograph of Plating Solution Surface with Air Agitation

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Figure 6 - Close-Up Photograph of Plating Solution Surface Without Air Agitation

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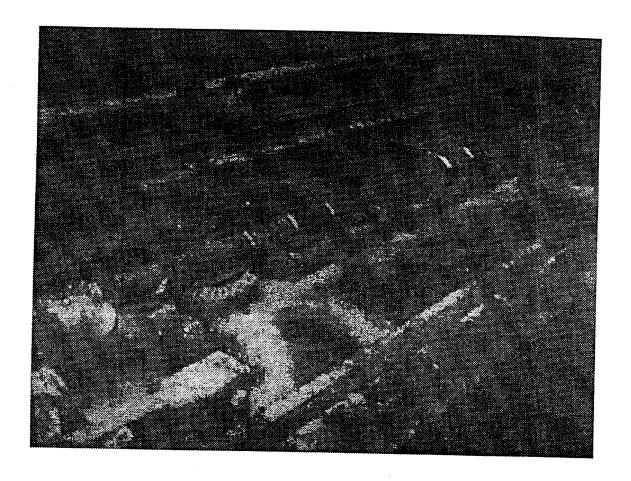


Figure 7 - Photograph of Plating Solution Surface with Air Agitation and Circulation
Discharge above Surface

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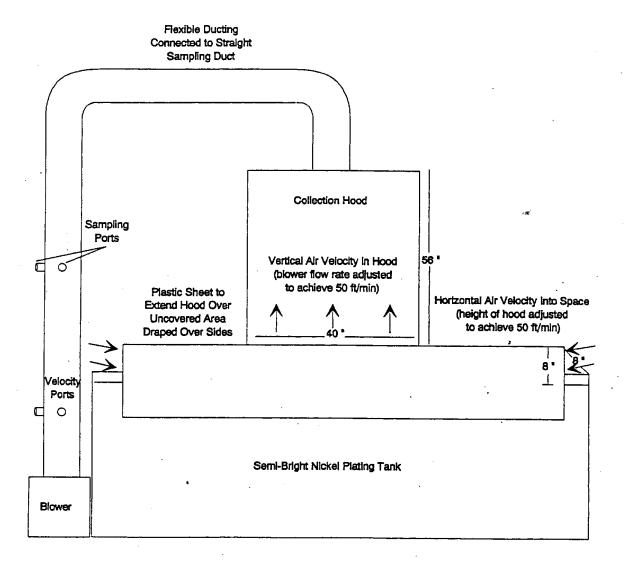


Figure 8 - Temporary Ventilation System with Sampling Location

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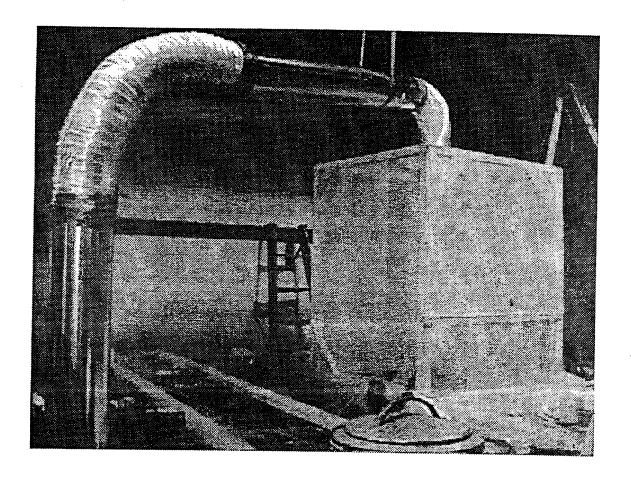


Figure 9 - Photograph of Temporary Ventilation System with Sampling Location

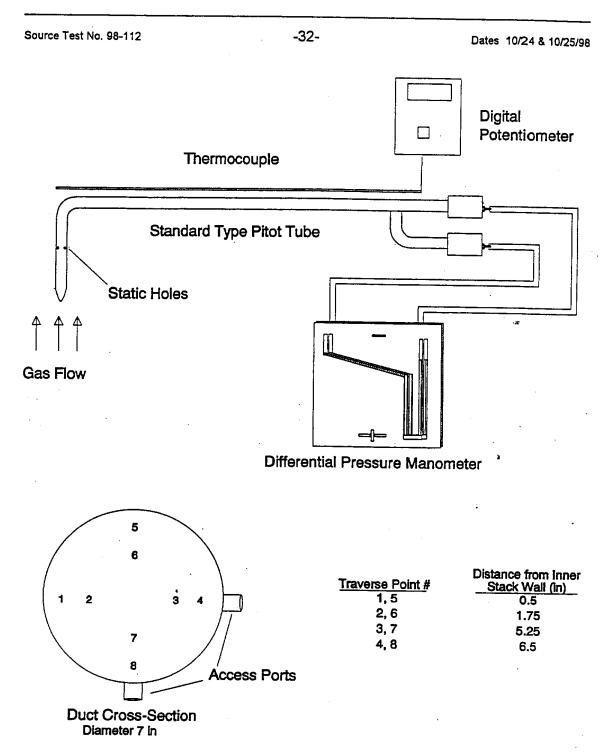


Figure 10 - Flow Rate Measuring Apparatus

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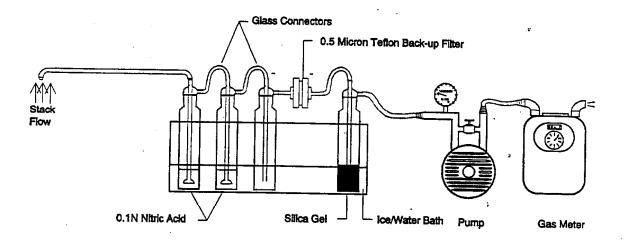


Figure 11 - Nickel Sampling Apparatus

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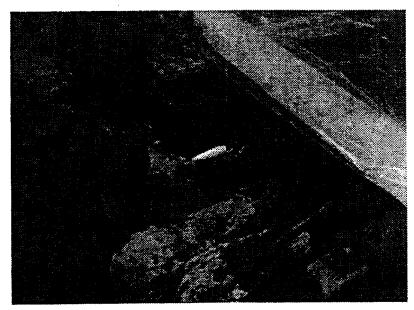


Figure 12 - Photographs of Smoke Test for Capture Efficiency

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SOURCE TEST CALCULATIONS

Average Velocity and Temperature

Run #1 with Air Agitation

	Velocity		Calculated							
Traverse	Head #1	Temp.	Velocity							
Point #	("H₂O)	(°F)	(fps)							
1	0.21	114	31.84							
2	0.20	112	31.02							
] 3	0.20	110	30.96							
[- 4]	0.22	112	32.53							
5	0.23	119	33.47							
6	0.20	118	31.18							
7	0.20	117	31.15							
8	0.25	118	34.86							
Average Ve	locity (fps)		32.13							
Average Te	Average Temperature (°F) - 115									

Run #2 with Air Agitation

Traverse Point#	Velocity Head #1 ("H ₂ O)	Temp.	Calculated Velocity (fps)
1 2 3 4 5 6 7 8	0.22 0.23 0.22 0.26 0.20 0.21 0.21 0.26	114 113 114 111 112 112 111 110	32.59 33.29 32.59 35.33 31.02 31.78 31.76 35.30
Average Ve	elocity (fps)		32.96
Average Te	mperature	(°F) -	112.125

Where: Calculated Velocity = $2.9 \times [Velocity Head \times (460 + Temperature)]^{0.5}$

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SOURCE TEST CALCULATIONS

Average Velocity and Temperature

Run #1 No Air Agitation

Traverse Point #	Velocity Head #1 ("H₂O)	Temp.	Calculated Velocity (fps)						
1 2 3 4 5 6 7 8	0.18 0.24 0.21 0.16 · 0.17 0.19 0.19 0.22	95 96 97 104 108 110 111	28.99 33.50 31.36 27.55 28.50 30.18 30.21 32.47						
Average Velocity (fps) 30.34									
Average Temperature ("F) - 103.875									

Run #2 No Air Agitation

Traverse Point#	Velocity Head #1 ("H₂O)	Temp. (°F)	Calculated Velocity (fps)
1 2 3 4 5 6 7 8	0.21 0.25 0.21 0.22 0.23 0.21 0.18 0.20	110 110 112 111 114 115 111 109	31.73 34.62 31.78 32.50 33.32 31.87 29.40 30.94
	elocity (fps)	(°F) -	32.02 111.5

Where: Calculated Velocity = $2.9 \times [Velocity Head \times (460 + Temperature)]^{0.5}$



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SOURCE TEST CALCULATIONS Flow Rate and Emissions for Run #1 with Air Agitation

Sample Train:	Nickel Train	#3						Input by:	M. Gariba	ıy	
SUMMARY											
A. Average Travers	ea Valocity										
B. Gas Meter Temp	perature /Lice 60	dog E 6	Ta			••••••	•••••		32.13	fps	
C. Gas Meter Corre	ection Eactor	ueg.r i	DI 1 0 11	ib Com	p. Meters	•)	• • • • • • • • • • • • • • • • • • • •	••••••	9	2 deg	F
D. Average Orifice	Preseum	•••••	•••••	•••••	• • • • • • • • • • • • • • • • • • • •	••••••	• • • • • • • • •		1.0023	\$	
E. Nozzle Diameter	·	•••••••		••••••	•••••	••••••	• • • • • • • • • • • • • • • • • • • •			"H2	_
	***************************************	••••••	••••••		••••••	••••••	••••••	••••••	0.2473	inch	1
F1. Stack Dimension			7 inch								
F2. Stack Dimensio	n #2		inch		M. Pitot C	orrect	tion F	actor	1.00	1	
G. Stack Cross Sec	t. Area	0.267	ft2	•	V. Sampli	na Tir	me			min	
H. Average Stack T	emp	115.0	deg F	. (O. Nozzle	X-Se	ct. An	ea	0.00033		
I. Barometric Pressi	⊔re	29.92	"HgA	F	P. Sample	Colle	ection	l		7 ma	
J. Gas Meter Pressi	ure (I+(D/13.6	30.00	"HgA	. (2. Sample	Coll	ection	L		7 mg	
K. Static Pressure		-0.57	"H20	F	R. Water \	Vapor	Conc	densed		ing Fine	
L. Total Stack Press	sure (I+(K/13.	29.88	"HgA	S	S. Gas Vo	lume	Meter	red	70.153		
T. Corrected Gas Vo	olume [(S x J/29.	92) x 52	20/(460)+B) x (c	••••••	••••••	••••••••	66.416	dscf	
PERCENT MOISTU	RE/GAS DENSI	īΥ									
U. Percent Water V	apor in Gas Sam	pie ((4.	64 x R)/((0.04	164 x R) +	· T)}			7.08	%	
V. Average Molecu					-	••			1.50		
Component		Fract.							,		
		riact.	x	Moist, I	Fract.	X		Molecular W	t. =		Wt./
Water	0.071		1.	000			18.0		1.27		
Carbon Dioxide	0.000 Dry		0.	929			44.0	•	.0.02		
Carbon Monoxide	0.000 Dry			929			28.0		0.00		
Oxygen	0.209 Dry			929			32.0		6.21		
Nitrogen & Inerts	0.791 Dry	Basis	0.	929			28.2	•	20.72		
				_				Sum	28.22		
FLOW RATE								17 17 17		·	
W. Goo Doneity Con			_								
W. Gas Density Con	ection Factor (2)	3.95/V)	.5	• • • • • • • • • • • • • • • • • • • •	••••••	••••••		****************	1.01		
X. Velocity Pressure	Correction Factor	or (29.9)	2/L)^.5	••••••		••••••	••••••		1.00		
Y. Corrected Velocity	y (A x M x VV x x	.)	•••••	•••••		•••••	••••••		32.56	fps	
Z. Flow Rate (Y x G	x ou)				•	•••••	•••••	•••••	522	cfm	
AA. Flow Rate (Stand	ard) (Z X (L/29.9	2) x (52	0/(460	+H)]}		••••••	•••••	*******	472	scfm	
BB. Dry Flow Rate (A	A X (U/100))		• • • • • • • • • • • • • • • • • • • •	•••••	•••••	••••••	••••••		438	dscfm	ו
SAMPLE CONCENT	RATION/EMISSI	ON RA	ΓE								
CC. Sample Concent	ration [0.01543 x	(P/T)1.						,	2 725 2 .		
onc. [5.	4,143xCC/	58.7 (Molec	uiar Wt	E. YZ				2.72E-04	_	म
E. Nickel Emission I	Rate (0.00857 x)	3B xCC	1						0.25072 1.02E-03		
T. NICKEI EMISSION F	tate [(.0001322 x	: Q x B	3 VTI								
SG. Isokinetic Sampli	ng Rate [(G x T	x 100)/(N x O	x BB)1			*********	•••••••	1.02E-03		
·	- -	, ,	_	71.			••••••		101.2	70	

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SOURCE TEST CALCULATIONS Flow Rate and Emissions for Run #2 with Air Agitation

Sample Train:	Nickel Train #7							Input by: I	/I.Garibay		
SUMMARY A. Average Traverse B. Gas Meter Tempe C. Gas Meter Correct	rature (Use 60 de tion Factor	g.F fo	r T <i>er</i>	np Con	np. Meters	:) :	•••••		32.96 99 1.0023	fps deg F	
D. Average Orifice P E. Nozzle Diameter									1.09 0.2435	"H20 inch	
F1. Stack Dimension F2. Stack Dimension		.7	inch		M. Pitot C	orrecti	on Fa	ctor	1.00		
G. Stack Cross Sect.		0.267		•					120	min	
H. Average Stack Te		112.0		F				a	0.00032		
I. Barometric Pressu		29.92	_						1.35		
J. Gas Meter Pressu		30.00	_						1.35	_	
	, ,	-0.57	_					ensed	93.1	_	
K. Static Pressure						•		ed	70,728	·.E	
L. Total Stack Pressu	.re (1+(1√13.	29.88	пg	^	5. Gas v	Jiume i	Merel	ea	10.120	GCI	
T. Corrected Gas Vo			20/(4	60+B) :	¢ C	•••••••	•••••	•••••••	66.121	dscf	
PERCENT MOISTUI											
U. Percent Water Va	apor in Gas Sam	ole ((4.	64 x	R)/((0.	0464 x R)	+ T))			6.13	%	
V. Average Molecul	ar Weight (Wet):										
Component	Vol. F	ract	x	Mois	t. Fract.	×		Molecular W	t =	١	/ \t/
Water	0.061			1.000			18.0	•	1.10		
Carbon Dioxide	0.000 Dry	Raeis		0.939			44.0		0.02		
Carbon Monoxide	0.000 Dry			0.939			28.0	,	0.00		
	0.209 Dry			0.939			32.0	•	6.28		
Oxygen				0.939			28.2	•	20.93		
Nitrogen & Inerts	0.791 Dry	Dasis		0.535			20.2	•	20.55		
								Sum	28.33		
FLOW RATE	•										
W. Gas Density Cor	rection Factor (2)	8.95/	١٨.5						1.01		
X. Velocity Pressure	Correction Facts	or /29 9	72/LY	^5					1.00		
Y. Corrected Velocit	~ (A ~ M ~ M ~)	0. (£0.)						•••••	33.34	fns	
Z. Flow Rate (Y x G										cfm	
AA. Flow Rate (1 x G	x 60)	32\ v. fE	2011	460±U		•••••	••••••			scfm	
									-	dscfm	
BB. Dry Flow Rate (/	•A X (∪/100))		•••••		••••••	••••••	• • • • • • • • • • • • • • • • • • • •	••••••	400	USCIII	•
SAMPLE CONCENT	RATION/EMISS	ION R	ATE								
CC. Sample Concen	tration [0.01543)	(P/T)]						3.15E-04	gr/dsc	of
DD. Sample Conc. [5		58.7	Mc	olecular	· Wt.)]		•••••		0.29058	ppm	
EE. Nickel Emission	Rate (0.00857 x										
FF. Nickel Emission	Rate ((.0001322	x O x	вву	Π		•••••		***********	1.23E-03		
GG. Isokinetic Samp	ling Rate [(G x T	x 100)(Ń	x O x B	B)]				99.9		



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SOURCE TEST CALCULATIONS Emissions for Ambient with Air Agitation

Sample Train:	Nickel Train #	4						. Input by:	M.Gariba	у	
SUMMARY										•	
	latania.										
A. Average Traverse V	tion (the co.	······	······		••••••	••••••••	•••••	••••••		fps	
B. Gas Meter Tempera	wre (Use 50 c	eg.r ro	rie	mp Co	mp. Meter	's)	•••••	•••••	10	O deg	F
C. Gas Meter Correction	n Pactor	•••••	•••••	•••••		•••••••••••••••••••••••••••••••••••••••	•••••		1.0042		
D. Average Orifice Pre	ssure	•••••	• • • • • •	• • • • • • • • •	• • • • • • • • • • • • • • • • • • • •		••••••		2.10	"H2	0
E. Nozzle Diameter		•••••	• • • • •	••••••••••••••••••••••••••••••••••••••	•••••••			•••••••		inch	ì
F1. Stack Dimension #			inc	h							
F2. Stack Dimension #2	2		inc	h	M. Pitot	Correc	tion F	actor			
G. Stack Cross Sect. A	геа		ft2		N. Samp	lina Ti	ne		285	min	
H. Average Stack Tem	p		deg	F	O. Nozzi	e X-Se	ct Ar	ea	2.00	ft	
I. Barometric Pressure.		29.92	-						0.200		
J. Gas Meter Pressure	(I+(D/13.6	30.07	_					1	0.306	-	
K. Static Pressure		00.01	"H2		R Water	. //apo	ACTIOL	densed	0.308	_	
L. Total Stack Pressure			"Hg		S. Gas V	vapo:	Make	red		ı WÎ	
	` `		_					*	228.859		
T. Corrected Gas Volun	ne [(S x J/29.9	92) x 52	0/(4	60+B) :	k C	• • • • • • • • • • • • • • • • • • • •		•••••	214.506	dscf	
PERCENT MOISTURE	/GAS DENSIT	Υ									
U. Percent Water Vapo	or in Gas Sam	ple ((4.	64 x	R)/((0.	0464 x R)	+ T))	•••••		1.52	%	
V. Average Molecular								•			
Component	Vol. F	Fract.	x	Mois	t Fract,	×		Molecular W	t =		Wt/
Water	0.015			1.000			18.0	-	0.27		
Carbon Dioxide	0.000 Dry	Basis		0.985			44.0	•	. 0.02		
Carbon Monoxide	0.000 Dry			0.985			28.0	•	•		
Oxygen	0.209 Dry			0.985			32.0	•	0.00 6.59		
Nitrogen & Inerts	0.791 Dry			0.985			28.2	•	21.96		
							20.2	•	21.50		
								Sum	28.83		
FLOW RATE	ı										
W. Gas Density Correct	ion Factor (28	3.95/V) [/]	٠.5	•••••	••••••		*******		1.00		
X. Velocity Pressure Co	rrection Facto	r (29.9)	2/L)^	`.5							
Y. Corrected Velocity (A	\ x M x W x X	}	• • • • • • •	•••••		•••••	•••••	******		fps	-
Z. Flow Rate (Y x G x 6	0)	• • • • • • • • • • • • • • • • • • • •					•••••			cfm	
AA. Flow Rate (Standard	i) {Z x (L/29.9;	2) x [52	0/(4	60+H) <u>I</u>	}					scfm	
BB. Dry Flow Rate (AA x	(U/100))		•••••		••••••		••••••	••••••		dscfn	n
SAMPLE CONCENTRAT	TION/EMISSI	ON RA	ΤE								
CC. Sample Concentration	on ID 01543 v	(P/T)1							0 005 65		
DD. Sample Conc. [54,14	43yCC/	58.7	(Mal	ecular '		••••••	*******				Cf .
EE. Nickel Emission Rate		3B v C C	/ /14101	o-uiai	**L)]		••••••	***************************************	0.02030	• •	
FF. Nickel Emission Rate	. (C.00007 X E		7·····	••••••••••••••••••••••••••••••••••••••	• • • • • • • • • • • • • • • • • • • •	••••••	•••••	•••••		lb/hr	
GG. Isokinetic Sampling	Rate ((G v T v	r 1000/	ן זיק כ 'N ∨	O v 29		••••••	••••••	••••••		lb/hr	
				- ~	J2					%	

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SOURCE TEST CALCULATIONS Flow Rate and Emissions for Run #1 No Air Agitation

Sample Train: N	lickel Train #	2						Input by:	M.Garibay	,	
SUMMARY											
A. Average Traverse Ve	locity .								30.34	4	
B. Gas Meter Temperat	une (Use 60 d	iea E fa	r Te	ma Can	nn Meter	re)	•••••	***************************************		deg F	-
C. Gas Meter Correction	Factor				p. 11.0101		••••••	***************************************	1.0023	ueg r	
D. Average Orifice Pres	e ine	***********		••••••	•••••••••••	•••••	•••••	••••••		#L 100	
E. Nozzle Diameter		•••••	• • • • • •	• • • • • • • • • • •		*****	•••••	***************************************		"H20	
L. HOZZIG DIAMERI	***************		•••••	•••••	• • • • • • • • • • • • • • • • • • • •	••••••	••••••	******************	0.3125	inch	
F1. Stack Dimension #1		7	incl								
F2. Stack Dimension #2			incl	ר	M. Pitot	Correct	ion Fa	actor	1.00		
G. Stack Cross Sect. Ar	ea	0.267	ft2					•••••	120	min	
H. Average Stack Temp		104.0	deg	F	O. Nozz	le X-Se	ct. An	ea	0.00053	ft	
 Barometric Pressure 	**********	30.00	"Hg	Α	P. Samp	le Colle	ction	••••••	2.95	ma	
J. Gas Meter Pressure (I+(D/13.6	30.20	"Hg	Α	Q. Samp	ole Colle	ection		2.95	ma	
K. Static Pressure		-0.50			R. Wate	r Vapor	Cond	ensed	79.4	_	
L. Total Stack Pressure	(I+(K/13.	29.96	"Hg	A	S. Gas \	/olume	Meter	edbe	110.584	dcŧ	
T. Corrected Gas Volum	e [(S x J/29.	92) x 52	20/(4	60+B) x	C	••••••	••••••	*****************	104.808	dscf	
PERCENT MOISTURE	GAS DENSI	ΤΥ				,					
U. Percent Water Vapo	r in Gas Sam	ple ((4.	64 x	R)/((0.0)464 x R)) + T))		*********	3.40	%	
V. Average Molecular \	Weight (Wet)):									
Component	Vol.	Fract.	x	Moist	. Fract.	×		Molecular W	t. =,	,	WŁ/
Water	0.034			1.000	-		18.0		0.61		
Carbon Dioxide	0.000 Dry	/ Basis		0.966			44.0		0.02		
Carbon Monoxide	0.000 Dry	/ Basis		0.966			28.0		.0.00		
Oxygen	0.209 Dry	/ Basis		0.966			32.0		6.46		
Nitrogen & Inerts	0.791 Dry	/ Basis		0.966			28.2	•	21.54		
-	•							•	4		
								Sum	28.63		
FLOW RATE				-	-						
W. Gas Density Correct	ion Factor (2	8.95/V)	^.5		· • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •	••••••	•••••	1.01		
X. Velocity Pressure Co	rrection Fact	or (29.9	2/L)	^.5		•••••	•••••		1.00		
Y. Corrected Velocity (A									30.49	fps	
Z. Flow Rate (Y x G x 6	0)	• • • • • • • • • • • • • • • • • • • •	•••••	•••••			•••••		489	cfm	
AA. Flow Rate (Standard	I) {Z x (L/29.9	92) x [5:	20/(4	60+H)]]	}			• • • • • • • • • • • • • • • • • • • •	451	scfm	
BB. Dry Flow Rate (AA x	: (U/100))	•••••	•••••	•••••	• • • • • • • • • • • • • • • • • • • •	•••••	•••••	•••••••	436	dscfm	1
SAMPLE CONCENTRAT	FION/EMISS	ION RA	TE								
CC. Sample Concentration	on 10.01543 s	x (P/T\)							4.34E-04	asidos	æ
DD. Sample Conc. [54,14										•	41
EE. Nickel Emission Rate									0.40059	• •	
FF. Nickel Emission Rate									1.62E-03		
GG. Isokinetic Sampling									1.62E-03		
iominate dempining	ware ((O x)	× 100)	(14 A	- x 00	·/j	• • • • • • • • • • • • • • • • • • • •	• • • • • • •	•••••••	100.5	70	



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Dates 10/24 & 10/25/98

SOURCE TEST CALCULATIONS Flow Rate and Emissions for Run #2 No Air Agitation

Sample Train:	Nickel Train	# 6						input by:	M.Gariba	ıy	
SUMMARY											
A. Average Traverse	Velocity.										
B. Gas Meter Tempe	rature (Use 60	dea F fr	or Te	mp Co	ma Matam		••••••	••••••		? fps	
C. Gas Meter Correc	tion Factor	acg., it	J, 10	inp co	inth' Mereta	·J	*******	•••••••		3 deg	F
D. Average Orifice P	ressure	**********		••••••	•••••••••		••••••	••••••	1.0023		
E. Nozzle Diameter	1000010		• • • • • •		• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •	••••••	***************		"H2	
a		*********	· · · · · ·			••••••	••••••	••••••	0.3168	inch	1
F1. Stack Dimension	#1	7	7 incl	h							
F2. Stack Dimension			inci	h	M. Pitot C	отес	tion E	actor	4.00		
G. Stack Cross Sect.		0.267		•	N. Sampli	na Ti		actor	1.00		
H. Average Stack Te		1120		F	O Nozzie	Y-C-	A.	ea		min	
I. Barometric Pressur	19	30.00	_								
J. Gas Meter Pressur	e (i+(D/13.6	30.23	_		O Sample	- C-II	ecuon) mg	
K. Static Pressure	0 (1.18/10.0	-0.50	-		Q. Sample	J'ann	ector	١,) mg	
L. Total Stack Pressu		29.96			Con Va	vapoi	CONC	densed	107.6		
	.5 (1. (10 15.	25.50	ng	^	S. Gas vo	iume	Mete	red	120.657	dēf	
T. Corrected Gas Vol	ume [(S x J/29.	92) x 52	20/(4	60+B):	x C	••••••	••••••	••••••	112.859	dscf	
PERCENT MOISTUR	E/GAS DENSI	TΥ									
U. Percent Water Va	por in Gas Sam	ple ((4.	64 x	R)/((0.	0464 x R) +	· T))	•••••	*************	4.24	%	
V. Average Molecula	ır Weight (Wet)):						•			
Component	Vol.	Fract.	x	Mois	t. Fract.	x		Molecular W	ե ≓		144.
Water	0.042			··				THOICCUIA! YY			Wt./
Carbon Dioxide		Dania		1.000			18.0	•	0.76		
Carbon Monoxide	0.000 Dry			0.958			44.0	,	0.02		
Oxygen	0.000 Dry			0.958			28.0	•	0.00		
Nitrogen & Inerts	0.209 Dry			0.958			32.0	,	6.40		
This ogen & mens	0.791 Dry	pasis		0.958			28.2	•	21.35		
								1			
								Sum	28.53	·	
FLOW RATE	•										
W. Gas Density Corre	ection Eactor (2	9 05 4 //	٠.			•					
X. Velocity Pressure C	Cuon racion (2)	5.331V) 5.430.01	1.J,		·····	•••••	••••••	•••••	1.01		
Y. Corrected Velocity	/A v M v M v M v N	Ji (∠3.3. ^	2/LJ*	.o	•••••••	•••••	•••••	••••••	1.00		
7 Flow Rate CV CV	(A Y W Y A Y Y Y Y	·)		• • • • • • • • • • • • • • • • • • • •	***************************************	••••••	••••••	•••••	32.23		
Z. Flow Rate (Y x G x	00)	··········			••••••	••••••	• • • • • • • • •		517		
AA. Flow Rate (Standa	10) (Z X (L)29.5	(2) X (52	:U/(40	50+H)]	·	••••••			470	scfm	
BB. Dry Flow Rate (AA	x (0/100))	• • • • • • • • • • • • • • • • • • • •	•••••	••••••	••••••	•••••	• • • • • • • • • • • • • • • • • • • •	•••••	451	dscfn	٦.
SAMPLE CONCENTR	ATION/EMISSI	ON RA	TE								
CC. Sample Concentra	tion [0,01543 x	(P/T)I	•••						4 025 24		
DD. Sample Conc. [54,	143xCC/	58.7	(Mole	acular \	Λ / † \]	*******	•••••	••••••	4.92E-04	-	ar .
EE. Nickel Emission Ra	ate (0.00857 x 1	BB xCC)o.		· · - /]	••••••	••••••	• • • • • • • • • • • • • • • • • • • •	0.45398		
FF. Nickel Emission Ra	te ((.0001322)	OYR	ידע <i>ב</i>	**********		•••••	•••••	*****************	1.90E-03		
GG. Isokinetic Samplin	g Rate I/G x T	x 1001//	N • 1		······································	••••••	•••••	•••••	1.90E-03		
	3 · · · · · · · · · · · · · · · · · · ·			~ ~ 00	/]	•••••	••••••	••••••	101.9	%	

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Dates 10/24 & 10/25/98

SOURCE TEST CALCULATIONS Emissions for Ambient No Air Agitation

Sample Train:	lickel Train #5				Input by:	M.Garibay	
SUMMARY							•
A. Average Traverse Ve	elocity		•		***************************************		fps
B. Gas Meter Temperat	ure (Use 60 dea F fo	or Temp Co	mn Meters	· · · · · · · · · · · · · · · · · · ·	***************************************	100	deg F
C. Gas Meter Correction						1.0042	ueg r
D. Average Orifice Pres							*****
_						2.10	"H20
E. Nozzle Diameter		*************	***************************************	*************	•••••••		inch
F1. Stack Dimension #1	•••••	inch					
F2. Stack Dimension #2)	inch	M. Pitot C	orrection F	actor		
G. Stack Cross Sect. Ar	ea	ft2	N. Samplii	ng Time		285	min
H. Average Stack Temp)	deg F			ea		ft
I. Barometric Pressure	30.00	"HaA	P. Sample	Collection	•••••	0.0325	
J. Gas Meter Pressure (I+(D/13.6 30.15	"HgA			L	0.0325	
K. Static Pressure	•	*H20	•		ensed	52.5	•
L. Total Stack Pressure		"HaA			red		
	` `	•					
T. Corrected Gas Volum	ne [(S x J/29.92) x 5	20/(460+B)	x C	***************************************		215.372	dscf
PERCENT MOISTURE	GAS DENSITY						
U. Percent Water Vapo	r in Gas Sample ((4	.64 x R)/((0	.0464 x R) +	· T))		1.12	%
M. Assessed Materials	41-1-1-1 047-15						
V. Average Molecular	vveight (vvet):				•		
Component	Vol. Fract.	x Mois	st. Fract.	×	Molecular W	/t. =,	Wt./
Water	0.011	1.000		18.0		0.20	
Carbon Dioxide	0.000 Dry Basis	0.989		44.0		0.02	
Carbon Monoxide	0.000 Dry Basis	0.989		28.0		0.00	
Oxygen	0.209 Dry Basis	0.989		32.0	·	6.61	
Nitrogen & Inerts	0.791 Dry Basis	0.989		28.2		22.05	
•	•				•		
					Sum	28.88	
FLOW RATE	•						
W. Gas Density Correct X. Velocity Pressure Co						1.00	
							_
Y. Corrected Velocity (A							fps
Z. Flow Rate (Y x G x 6							cfm
AA. Flow Rate (Standard BB. Dry Flow Rate (AA)							scfm dscfm
DD. DIJ I ION NAW (AN)	(0,100),	****************	*****************	***************************************	••••••••		uscim
SAMPLE CONCENTRA	TION/EMISSION R	ATE					
CC. Sample Concentrati	on [0.01543 x (P/T)]	••••		***************	2.33E-06	gr/dscf
DD. Sample Conc. [54,1					***************************************	0.00215	ppm
EE. Nickel Emission Rat	e (0.00857 x BB xC	C)	••••••		***************************************		lb/hr
FF. Nickel Emission Rat	e [(.0001322 x Q x l	ввутј	•••••				lb/hr
GG. Isokinetic Sampling	Rate [(G x T x 100]	V(N x O x B	B)]		••••••		%

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Dates 10/24 & 10/25/98

SOURCE TEST CALCULATIONS Results with Calculation Footnotes

Run#	lb/hr	lb/hr-ft2 tank	lb/hr-ft2 parts	lb/hr-cfmair	gr/dscf	mg/dscm	mg/hr	amorna	/A L -
1 air	1.02E-03	1.06E-05	9.43E-06	2.04E-05	2.72E-04	0.622	463	amperes	mg/A-hr
2 air	1.23E-03	1.28E-05	1.14E-05	2.46E-05	3.15E-04	0.721	558	2162	0.214
Average	1.13E-03	1.17E-05	1.04E-05	2.25E-05	2.94E-04	0.672	510	N/A	N/A
Ambient	N/A	N/A	N/A	N/A	2.20E-05	0.0503	N/A	2162	0.214
1 no air	1.62E-03	1.69E-05	1.50E-05	NA	4.34E-04	0.993	735	N/A 2159	N/A
2 no air	1.90E-03	1.98E-05	1.76E-05	N/A	4.92E-04	1.126	862		0.340
Average	1.76E-03	1.83E-05	1.63E-05	NA	4.63E-04	1.059	798	2162 2161	0.399
Ambient	N/A	NA	N/A	NA	2.33E-06	0.00533	N/A	N/A	0.369 N/A

Where:

Surface Area of Tank Solution =

96 ft2

Surface Area of Parts =

108.2 ft2

Air Agitation Rate Run #1 =

0.52 cfm/ft2tank

Air Agitation Rate Run #2 =

0.52 cfm/ft2tank

lb/hr is from the Flow Rate and Mass Emission Rate Spreadsheet

lb/hr-ft2 tank = lb/hr / Surface Area of Tank Solution

lb/hr-ft2 parts = lb/hr / Surface Area of Parts

lb/hr-cfmair = lb/hr-ft2tank / Air Agitation Rate per ft2tank

gr/dscf is from the Flow Rate and Mass Emission Rate Spreadsheet

mg/dscm = gr/dscf 2288.3

 $mg/hr = lb/hr \times 453592$

amperes is the average plating amperage during testing period from A-hr meter (A-hr/hr)

mg/A-hr = mg/hr / average plating amperage during testing period

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Dates 10/24 & 10/25/98

APPENDIX

Field Data, Calibration Data, and Laboratory Results

		·	

SOUTH COAST AIR QUALITY HANAGEHERT DISTRICT

	Ten	t No.	98-1	12 on: . Fo	(I)	/·	0.‱11⊾1		Dat	e: <u>/۵//</u> ple Tra	24 198			
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	Prol	he Coo	03 011	• e <u>15</u> '	"llg_vac	•			Pro	be <u>0.00</u>	2 cla	€ <u>8</u>	"llg	yac
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esta		+15	6	173-1	0.14		50-17	0.852	2.61			102	96	2
hing e-lidize		145	7	188.8	0-19	111	30.21	のカラー	2.65			107	98	6
ال-ح		760	8	201.805	0.22	11.0	32.47	0.917	2.10			11/0	102	8
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	lozzle Gromet			<u> 3000</u> '	min (<u>D- 2</u>	<u>(کر7)</u> ۱۱۹۸"	•	ecorded Llot Fac		<u>C.U</u>		•••• /	00	
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SOUTH COAST AIR QUALITY HANAGEHERT DISTRICT

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7' (mc	Sample	Gas Heler		ick		alculate	1		Filter	Hele	r lemp	i .
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	+15	1	217.6	0-21	110	31.73		3.06		 		100	3
	+30		235-6	025	1080	39.61	1-005	3-65				100	=
	+45	3		0.21		31-78		3-11		<u> </u>		102	5
	+60	4	269.3	0.22	17.1	32.20	0-942	2.7-0			1	100	
	 	-5	279.5	0.23	1177	33-32	0.961	3-38			106	104	5
	+15		244.8	0.21	115	31.86	0.917	3.06			105	101	5
	+25			0.15		29-40	0-852	2.76			106	102	5
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SOUTH COAST AIR QUALITY HAPAGEHERT DISTRICT

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		+38	2	341.9	10.20	112	31.01	0.546	1.02			88	85	15
		+45			0.20		30.96	0.547	1.00			90	€ 86	5
C2 53	4.04	+63	1	358-9	0.22	112	22.50	<u>(1777)</u>	11.12			72)	59	3
K Ch		H15	5	30.8	0.23	119	33-H6	0.570	1.15			95	93	5
}∕e		+38	6	376.5	0.20	118	31.18	0.532	1.00			95	93	5555
Hing		+45	7		0-20			0.533				100	95	5
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SOUTH COAST AIR QUALITY HANAGEHERT DISTRICT

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								Post	t-Test	Leak Ch	eck:		
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		.*	(dcf) "	("II ₂ 0)	•F	((px)	(cfm)	("H2O)	"F	·°F	(In	Out	
	<u> </u>		<u> </u>	<u> </u>	144								
1:1500		<u> </u>	344-587	0 44	11/1	22.68	0.543	1.05			98	97	4
	+15		403.1	0.22	113	33.29	0.556	1.10			97	97	A
	+30	2.3	420.7	0.22	114	20.58	0.543	1-06			101	98	4
	+45	4	430.4	0.26	177	35.33	0.543	1.27			103	48	5
	+60	_4_	430.4	UFF						<u> </u>			
	+15	5	439.5	0.20	112	31.01	0.519	0.968			100	98	<u>5</u> 5
	730	6	448.4	0.21	112	31.78	0.331	1-01		<u> </u>	100	98	
	145	7	1157-0	0.21	1//	31.75	0.532	1.02			103	79	4 5
	+60	8	465.325	0.26	110	35.30	0.592	1-27			104	10n	<u>.</u> 5
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Potenti				(Cal: 🗍	0/21/0	8)	‡_			} _	_ + _ ,	Sta	
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Meter C	lorr.	Factor	r: [']	1.002	? '			710	<u> </u>]	84		•
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SOUTH COAST AIR QUALITY HANAGEMENT DISTRICT

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SOUTH COAST AIR QUALITY HANAGEMENT DISTRICT

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1150	 		114.0					211			105	99	417
105			135.2					2.1			105		4.5
1-195			150.3					7.11		~:	106		4.5
-210			162.4					2.1			105	991	4:5
-225			174.5					2.1	•				4.5
-240			1860.10	•				2.1	·		105	99	4.5
+255			198.7					2.1			105	99	4,5
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	No. <u>98-11</u>		HOOD DIECT	Date 10/24/98 AT FOSS PLATING	
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Proto				F CYCLONIC FLOW	
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'itot '	Tube No.	NIST (Cal	: 2/12/98)	14 724	
				7 - 7 6	tack Lmensi

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DATA SHEET FOR THERMOCOUPLE - POTENTIOMETER CALIBRATION

Date $(o-2l-9)$ & Calibration by To Calibration for: Semi annual V Bi Monthly Lead Wire STOC #: $SO20$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	213 0	2 0 2	+		J. T.	1+	
Date Calibratio Calibratio Sem Bi N Wd 3 \leftarrow Lead Wire ST	COMMENTS Sensor Ref. Ch		213 215	410 4(1 41)	411 4(1	710 7131	7097	
ND3 (\$	$\begin{array}{c} \Delta^{\bullet} F = \\ (B-A) \end{array}$ $Ch#2 \qquad Ch#1 Ch#2$	2,	2	2	2		- - + +	
Field Meter: No3/4 STQC #: S/N Reference: STQC #: S/N Temperature Source: NO3/4	Temp. A B Sensor Ref. Ch#1 C	20113 212 214	512 712	7	カ <i>かって</i> カカフ1カ	716 717	2)(2	7

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DRY GAS METER COEFFICIENT CALCULATIONS

CALIBRATION PERIOD: SEMIANNUAL SEMIANNUAL OTHER OTHER Compensated dry gas meters:		
rature compensate $(\frac{520}{460+\overline{1}})$ Pbar $(\frac{520}{460+\overline{1}})$ Pbar $(\frac{520}{29.92})$ s compensated draged values in their resuded in their		
1.) For non temperature Q'_{ds} and Q'_{ds} Q_{ds}		
ow Rote ow Rote std (scfr std (scfr std (scfr std (scfr std (scfr std scfr scfr scfr scfr scfr scfr scfr scfr		
Standard Dry Gas Meter 10# - Average Meter 10# - Average Meter 10# - Average Meter 10# - Field Dry Gas Meter 10# - Field Dry Gas Meter 10# - Average		
AMBIENT TEMPERATURE AMBIENT TEMPERATURE Standard Dry Gas Meter 10#		
AMBIENT T AMBIENT T Approximate Q (cfm) 1 1 3/4 3/4 1 Approximate Flow Rate Q (cfm) Q (cfm)	1/2	3/4

of the control of the following of the control of t	ALION BASEDS	on led tolena	Sell or this last	STATE OF STATE OF	E SECTION	Section of the sectio	P. Lenis Harles St.	SAME TO THE	Con Assessment	A COLUMN SANCES	A Company of the Company	AND SECTION OF SECTION SECTIONS		५५ तम् वे पुर्वत्सम् वतस्त्रकृ
	STANDAL	AD THENT	TETCATI	CTANDADD IDENTIFICATION (S/N) AID	NOS. VOCIA	TH COAST	AIR QUAL I FOR DRY	ITY MANAG	SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DATA SHEET FOR DRY GAS METER CALIBRATION	TRICT TION	a 0	DATE: CALIB. BY:	(6 -2 T	1-98 N
er sage nç	DRY GA	DRY GAS METER IDENTIFICATION	I DENT I F	ICATION (8C (N/S)	8 (2470	. 0	•			. ,	CALIBRATION FOR:	IN FOR:	
	DRY GA	DRY GAS METER IDENTIFICATION BAROMETRIC PRESSURE (Pbar)	IDENTIF SSURE (§	(STQC)	(0) (0)	ブ		·		,	SEMI ANNUAL MONTHLY OTHER	8	5
	AMB I EN	AMBIENT TEMPERATURE	ATURE		0/		•	17071	} -					
Approx.	Total		Crit.		Secondary	/ Standard Dry		Gas Meter				(Dry Ga	Gas Meter)	
			ΔP In H ₂ 0	Temp. (°F) In/Out	Press. In H ₂ 0) In/Out	Meter Read. CF	Time Min: Sec.	Elapse Time: Min.	Flow Rate CFM	Temp. (°F) In/Out	Press. (in H ₂ 0) In/Out	Meter Read. CF	Time Min: Sec.	Elapse Flov Time: Rate Min. CFM
		Start				187,5	0				4.420	0.5)9	0	
2		End	,			203.9			- :		4.42.0	628.3		
		Avg.or Total		10.	4,3	1 1	2(3130			16			21.32.61	
		Start				203.0						1829	0	
	· •	End			\	201.7			٠.			1.969		
	•	Avg.or Total		10	4.3	•	10:01		,	17			10.09.30	
•		Start				2(1.8		·	•			636.3	0	
~	•	End				252.3		٠				9.649		
		fota 1		10.	4.3		17.48.79			71			17.355	
. (·	Start				306.3					6.3.9	730.2	0	
1/		End				312-1					5.3.9	736.1		
		Avgpr		70	2.3		19.02.01			71			11.0471	
•		Start				312.2				· / /		298F	0	 -
	•	End				317.3	131.06		, ,			741.2		
		Avg.or Total		10	2.3					7(-		9.4.33	-
		Start				317.4		 				741.3	0	
		<u></u> -		<u> </u>	\ _	noeu	-		•		<u> </u>	T		·,

STANI DRY C DRY C BAROY	STANDARD IDENTIFICATION (S/N) DRY GAS METER IDENTIFICATION (S/N) DRY GAS METER IDENTIFICATION (STQC BAROMETRIC PRESSURE (P _{bar}) AMBIENT TEMPERATURE	TIFICATI IDENTIF IDENTIF ESSURE (ION (S/N) FICATION (TCATION (8 ₀ 8 √2√	NOT (S	AIR QUAL!	GAS METE	TH COAST AIR QUALITY MANAGEMENT DISTRICT ATA SHEET FOR BRY GAS METER CALIBRATION OF TO THE CALIBRATION OF THE CALIBRATICS OF THE CALIB	TRICT	a 0 0	DATE: (8	(8 - 7 NN FOR: JAL	121-9 18071	
Approx. Total		crit.		Secondary	Standar	Standard Dry Gas Meter	; Meter				(Dry Ga	(Dry Gas Meter)		
		ΔP In H ₂ 0	Temp. (°F) In/Out	Press. In H ₂ 0) In/Out	Meter Read. CF	Time , Min: Sec.	Elapse Time: Min.	Flow Rate CFN	Temp. (°F) In/Out	Press. (in H ₂ 0) In/Out	Meter Read. CF	Time Min: Sec.	Elapse F Time: R Min. C	Flow Rate CFM
	Start				468,2	.o.				15(3)	612 Y	0		
/6/	End				457.8		• •			61/51	0'779			
)	Avg.or Total		70	8,1		17.5.7 Ca			1470			(8.21.7		
	Start	٠.			62379	0.	,,,,,				(225)	၁		1
•	End				471.0			•			545			
	Avg.or Total		70			24.3020			10		8-48	24.17.40		
	Start				471.1	O					634.9	0		ľ
	End		\ \ \		L'9Lh	-					40.49			!
	fotal r		20			10.78.65			20			630.87		
	Start				512.1	0				5362	<u>5</u> 675.0	0		
7/4	End	٠		1	531.8					2325	694.4	_		
	Avg.or		70	3.2		14:SH			70			25-308		
	Start				531-9	0		,			9-469	0		/
	End				543.0			: j			705.4			
·· .	Avg.or Total		70	-		1402.45	1		70.		1	28.09.5	13,800	
•	Start				543.	0	•				705.5	0		

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DRY GAS METER COEFFICIENT CALCULATIONS

CALIBRATION PERIOD.	BIMONTHLY	SEMIANNUAL X.
	DATE: 7-31-93	PERFORMED BY:
	BAROMETRIC PRESSURE (P bar) $\frac{H.(6)}{100}$ in Hg	AMBIENT TEMPERATURE OF

AMBIENT T	AMBIENT TEMPERATURE	7	/0 °F	. PE	PERFORMED BY: TN OTHER
Approximate	Standard	Standard Dry Gas Meter ID#	•	012186	
Flow Rate	1		Average Meter	Corrected	1.) For non temperature compensated dry gas meters:
(cfm)	Flow Rate Q _{std} (cfm)	Temperature T (°F)	Pressure P (in H ₂ 0)		Q'std ≔
٠.					o ds o ds
1/4					2.) For temperature compensated dry gas meters:
					\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \
٠					$Q_{ds} = Q_{ds} \left(\frac{par}{par} \right)$
1/2	•				(29.92 /
•					3.) \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \
			٠		
3/4					"ds 1 to committee in these columns must fall within the
					ranges indicated in their respective column headings.
-					*** The computed values in this column must be areater than 0.98
_					and less than 1.02, i.e., 0.98 < (♥ 😇 🕻 < 1.02
					(sp sp)
	Field Dry (Field Dry Gas Meter ID#	NOTIC	 	Overall Avg., 74.= (* 0023
Approximate		H			

7-31-98 CALIBRATION FOR: SEMI ANNUAL CALIB. BY:_ MONTHIL Y DATE: SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DATA SHEET FOR DRY GAS METER CALIBRATION STANDARD IDENTIFICATION (S/N) AT 714787247DRY GAS METER IDENTIFICATION (STQC) NOTLY DRY GAS METER IDENTIFICATION (S/N) BAROMETRIC PRESSURE (PL.)

DANGELLIE TRESSORE (Thar)	12 Par/	2137	•			
AMPIENT TEMPEDATURE		0/	•	·		JIMER
WINTERN SERVICES			•			•

Approx.	Total		Crit.		secondary	Secondary Standard Dry Gas Meter	1.Dry Gas	Meter				(Dry Ga	(Dry Gas Meter)		.
SFM Project	CF		Orif. ΔP in H ₂ 0	Temp. (°F) In/Out	Press. In H ₂ 0) In/Out	Meter Read. CF	Tine Min: Sec.	Elapse Tine: Min.	Flow Rate CFM	Temp. (°F) In/Out	Press. (in H ₂ 0) In/Out	Meter Read. CF	Time Min: Sec.	Elapse F Time: R Min. C	Flow Rate CFM
		Start				439.3	0			25.25	00/	203.6	9		
>^4		End				445.2				35.25		509.6			
		Avg.or Total		10	<u> </u>		21.23.02				۰۲۰		27.47.22		
		Start				837	0					8.905	0		
	÷	End			\	450,3		. •	•			8.415	10.05, 81	. !	
	·	Avg.or Total		70	\ \ \ \ \ \		18.0813				٥٤.				 '
		Start				450.4	0	-				0,5/5	0		
	٠	End				4559						520.2			
		fota or		70	1.05		P.5713				06.		18,54.00		
- 6		Stärt				8-54,	0				3.2.6	540.2			
1	· • · · · · · · · · · · · · · · · · · ·	End				4841			-		3.2-1.0	3.9250-			
7		Avg.pr		70	3.4		14.57,60				70		5020-5		
		Start				484.2	Q: -					548.7	0		
	•	End				L'05+			•			555.2		******	Ì
		Avg.or Total		10	3.4		11.40.28				70		11.38.14		
		Start			.	490.8	Q					6,55,5	0		
•	_	<u>.</u>		/	7) "		<u>.</u>			7	- 014		<i>-</i>	

Approx. Total CF Project Start	Crit. Orif. AP in H ₂ 0	AMBIENT TEMPERATURE Dar'	DRY GAS METER IDENTIFICATION (STQC) N BAROMETRIC PRESSURE (Par)	9,16 9,16					SEMI ANNUAL. MONTHLY OTHER	SEMI ANNUAL Monthly Other	WI.	$\langle $	
ject Cr			Secondary	11	Standard Dry Gas Meter	Meter				(Dry Ga	(Dry Gas Meter)	_	
Start.		Temp. (°F) In/Out	Press. In H ₂ 0) In/Out	Meter Read. CF	Time Mfn: Sec.	Elapse Time: Min.	Flow Rate CFN	Temp. (°F) In/Out	Press. (in H ₂ 0) In/Out	Meter Read. CF	Time Min: Sec.	Elapse Time: Min.	Flow Rate CFM
٠,٠		/		5384	0				6.1-7.2	573.9	0		
End				5(8.4					6.12.2	583.1			
Avg.or Total	or .	10	6.2		12.36.59			20			12.47.19		
Start				9.815	. 0					8883	0		
End				527 2						591.9			
Avg.or Total	or	16	7.9		(0.57.85		·	70			10.45.96		
Start				£ 125	0	٠				592.0	0		
End				5406	16:405	7				602.0			
Avg.or Total	or	0/_	2.9		0510,51			70			12.3099		1
Start	دد			540.8	0				0000	y-50900	9		
End				249.7					8.20	8.419			.
Avg. pr	pr	10	(0.5		8.39.80			70			8.49.68		1
Start	دة			5व.१	0	•				0.319	0		1
End				555.1			·			620.3	•		
Avg.or Total	- e	. 02	(0.5		5.04.17			70			5.05.68		.
Start				557.3	۵.		-			620.5	0		,

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DRY GAS METER COEFFICIENT CALCULATIONS

CALIBRATION PERIOD:

*** The computed values in this column must be greater than 0.98 • & •• The computed values in these columns must fall within the ranges indicated in their respective column headings. 1.) For non temperature compensated dry gas meters: 00. $\left(\vec{7}_{ds} \div \vec{7}_{ds} \right)$ 2.) For temperature compensated dry gas meters: BIMONTHLY
SEMIANNUAL OTHER Overall Avg., Yds=_ Pbar + 13.6 29.92 and less than 1.02, i.e., 0.98 < Average Coefficient Pbar + 13,6 29.92 $Q'_{std} = Q_{std} \left(\frac{520}{460 + \overline{t}} \right)$ (Y ds max -Y ds min) <=0.010 Q'f or f Ods a'ds = a_{ds} PERFORMED BY: 11 3.). Yds = Q'std DATE: 2/30/98 Y_{ds} < (1+/- 0.05) .0039 Coefficient 009 003 D. 999 007 200 000 0,996 SO 6. 00. 0 Corrected Flow Rate Q'a(scfm) O_{std} (scfm) Flow Rate Corrected BAROMETRIC PRESSURE (Pbgr) 2912 in Hg P (In H₂0) p (in H₂0) Pressure Pressure No7 Avarage Meter Average Meter Standard Dry Gas Meter 10# Field Dry Gas Meter ID#.__ Temperature T (°F) Temperature T (°F) AMBIENT TEMPERATURE Flow Rate Q_{std} (cfm) Flow Rate Q_{ds} (cfm) Approximate Approximate Flow Rate Flow Rate Q (cfm) 3/4 1/2 0 (cfm) 1/4 3/4 <u>/</u> 1/2

7-30-98 CALIBRATION FOR: SEMI ANNUAL CALIB. BY: MONTHLY OTHER DATE: STANDARD IDENTIFICATION (S/N) 78 | DATA SHEET FOR DRY GAS METER CALIBRATION DRY GAS METER IDENTIFICATION (STQC) NO DRY GAS METER IDENTIFICATION (S/N) BAROMETRIC PRESSURE (Pbar). AMBIENT TEMPERATURE

Approx.	Total		crit.		Secondary	Standar	ry Standard Dry Gas Meter	Meter			·	(Ory G	(Ory Gas Meter)		1
Project	<u>ن</u>		Orit. AP In 11 ₂ 0	Temp. (°F) In/Out	Press. In H ₂ 0) In/Out	Meter Read. CF	Tine Min: Sec.	Elapse Time: Min.	Flow Rate CFN	Temp. (°F) In/Out	Press. (in H ₂ 0) In/0ut	Meter Read. CF	Tine Min: Sec.	Elapse Time: Min.	Flow Rate CFM
		Start		1		3.198	0				0.000	871.3	0		
7/2		End				714.5					6-0-2-0384	384.3			
}	į	Avg.or Total		70	2.9		89.8691			20	ï		16.45.22		
		Start	•			346	Ö.					88 9.4	0		
		End				8.18	•		•			9 1 of			
	,	Avg.or Total		10	2.9	·	83:13:22			70			2209.49		
		Start				ું કે કે કે	0					L-105	0		·-
		End		\)-20b						911-9			
-		Avg.pr	·	0/	6.2		13.11.51			.70			(3.01.2		
-		Start				410.7	0				3825	9.02	0		
<u> </u>	<u> </u>	End	•			422.8					93-35	132.9			
		Avg.Pr		10	(ه)		11.5709			70	·		12,02,40		
		Start				423.0	೦	• .				933.1	0		/
		End				428.0						138.2			
,		Avg.or Total		. 06	۰۵۱		4.56.20			70	•		4.59:54		,į
		Start				428.2	Q	•				138.4	0		•
		End				435 4	_ 					AU3. 4		· ·	·* _{6,}

CALIBRATION FOR: SEMI ANNUAL CALIB. BY: MONTHL Y OTHER DATE: STANDARD IDENTIFICATION (S/N) 78.12470NO.7 DRY GAS METER IDENTIFICATION (STQC)_ DRY GAS METER IDENTIFICATION (S/N) BAROMETRIC PRESSURE (P_{bar}) AMBIENT TEMPERATURE

Approx. Total	Total		crit.	٠.	Secondary	/ Standar	ry Standard Dry Gas Meter	s Meter				(Dry Ga	(Dry Gas Meter)		· .
Project			ΔP in H ₂ 0	Temp. (°F) In/Out	Press. in H ₂ 0) In/Out.	Meter Read. CF	Time Min: Sec.	Elapse Time: Min.	Flow Rate CFN	Temp. (°F) In/Out	Press. (in H ₂ 0) In/Out	Meter Read. CF	Time Min: Sec.	Elapse F Time: R Min. C	Flow Rate CFM
		Start	•			289.G	Ö			M.	0/2/	799.4		→4	 .
74		End				2.94.9	:				1:0:1	804.8			
		Avg.or Total		70	1.2		17.3629			70			18.02.96		
		Start				295.0			÷			804.9	0		
		End				300,7		. ·		1		810.6			
		Avg.or Total		70	1.2		(8 59.20			70			P 0217		
•		Start				300.8	0					21018	0		
	•	End				3079						817.6			
		fota.pr		70	1.2		12.34.51			70			2304.2	,-	
		Stärt				5183	0				31-1-4	\$28.0	Ç		
		End				325.1.					37.5	834.9			
1/		Avg.pr		70	3.3		12.41.79			06			17.57.86		
	•	Start				325.2	0		,			835.0	0		
	•	End				331.8			•		1	2-148			
		AVG.or Total		70	33		(3)(13)			70			12,1159		
		Start				6-186	0					9/1/8	0		
_		-			1	0 0 7 7			,	T	Ť			•	

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	·		

U.S. DEPARTMENT OF COMMERCE

NATIONAL INSTITUTE OF STANDARDS AND I ECHNOLOGY,

REPORT OF SPECIAL TEST

March 11, 1998

Two Pitot-Staric Tubes

submitted by

South Coast Air Quality Management District
Applied Science & Technology
21865 E. Copley Drive |
Diamoud Bar, CA 91765 4182

The calibration of the Pitot static tubes were performed in the 1 m (three-foot) by 1 m (three-foot) MIST Low Velocity Airflow Facility. The instrument under test was supported near that presented negligible interference to the flow. The air speed was measured by the MIST laboratory standard laser velocimeter on the conterline of the numel, instrument of the Pitot-static tubes. The air temperature, humidity, and atmospheric pressure were measured inside the tunnel.

The calibration of the Pilot-static tube consists of determining the calibration factor, K, defined as the square root of the ratio of the air speed indicated by the instrument under test to the air speed indicated by the NIST inhoratory standard velocimeter. K may be a function of the Reynolds number, Re, which is expressed as

Re = Vd/v

where V is the air speed, d is the diameter of the Pitot-static titbe, and v is the kinematic viscosity. Two calibration cycles were done, separated by a shutdown. Each speed in each cycle is measured five times:

Report of Special Test
Test Date February 12, 1998

Page 1 of 5

REPORT OF SPECIAL TEST South Coast Air Quality Mgmt. District

2 Pitot Static Tubes

Tables 1 and 2 and Figure 1 show the expanded uncertainty values for the NIST air speed calibration facilities. The dam listed in the remaining tables are calculated from the means of the 10 measurements at each speed. Listed are the air speed measured by the NIST standard, K, Re. and the expanded uncertainty of the measurements for the instrument under test.

The expanded uncertainty of the measured values for the instrument under test. U, is given by?

where k is the coverage factor, taken to be 2, and the u are the contributions to the uncertainty from various sources. For this calibration, there are two sources of uncertainty: u is the standard deviation of the ten measurements at each speed, and u is one half the uncertainty at a given speed shown in Tables 1 and 2 and in Figure 1, which was obtained through the characterization of the NIST standards.

For the Director.

National Listimic of Standards and Technology

or. George E. Miningly Leader, Fluid Flow Group

rocess Measurements Division

Chemical Science and Technology Laboratory

Report of Special Test

Test Dair February 12, 1998

Page 2 of 5

^{&#}x27;N. E. Mease, W. G. Claveland, Jr., G. E. Meningly, and J. M.: Hall, "Airspeed Calibrations at the National Institute of Science and Technology, Proceedings of the 1992 Measurement Science Confetance, Anahelm, CA. 1992.

PR.N. Taylor and C.E. Kuyan, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results," NIST Technical Note 1297, Nericaal Institute of Standards and Technology, January 1993.

Expanded Uncertaintles for NIST Air Speed Facilities

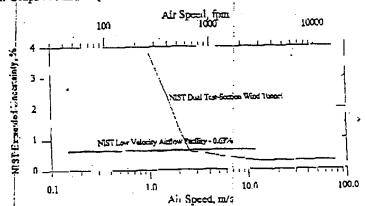
Table 1. Expanded Uncertainty of the NIST Low Velocity Airflow Facility

Air Speed, m/s	Uncertainty, (%)	Air Speed, form
up to 10	0.6	սը to 2200

Table 2. Expanded Uncertainty of the NIST Dual Test-Section Wind Tunnels

Air Speed, m/s	Uncertainty, %	Air Speed, fpm
1	3.8	200
2	1.3	400
3	0.6	600
5	0.45	1000
10	0.31	2000
15 - 75	0.28	3000 - 15000

Figure 1. Graph of NIST Expended Uncertainties - all facilities



Report of Special Test Text Date

February 12, 1998

Page 3 of 5

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SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT 21865 Copley Dr., Diamond Bar, CA 91765-4182

MONITORING AND ANALYSIS LABORATORY ANALYSIS REPORT

TO	Mike Garibay, Engineer II Source Testing & Engineering	LABORATORY NO	93008-02
	Monitoring & Analysis	REFERENCE NO	JSV-25-50
CAMPIE	Seven Nickel Trains	SOURCE TEST NO	98-112
SAMITLE	One Reagent Blank	PREPARATION NO	92938-12
SOURCE	Foss Plating Nickel Plating Tanks 8140 Secura Way Santa Fe Springs, CA	DATE RECEIVED	10/27/98

ANALYTICAL WORK PERFORMED, METHOD OF ANALYSIS, AND RESULTS Nickel by CARB Method 433

Equip Number(s) Sample point	10 field blank	2 no air	6 no air	3 air	. 7 air	4 amb	5 amb
Moisture gain (loss), g	(0.1)	79.4	107.6	109.0	93.1	71.4	52.5
Silica gel expended, percent Notes on train condition	<10 (1)	60 (2)	65	50 (3)	60 . (3)	85	60
Total nickel, ug	16.5	2950	3600	1170	1350	306	32.5

Comments and deviations:

(1) New filter

(2) Bath solution on probe exterior

(3) Solvent-like odor, possibly alcohol.

M&AD RECEIVED

DEC 3 0 1998

M&E BRANCH

Samples were reported with reagent blank subtracted. Reagent blank was 2.5 ug total. Samples were analyzed by West Coast Analytical Services (WCAS) by ICP/MS. (see attached report WCAS Job No 39762)

Date Approved:

Approved By

Rudy Eden, Senior Manager

Laboratory Services

E:\astd\...\9300802.doc



November 10, 1998

SOUTH COAST AIR QUALITY MANAGEMENT Laboratory Services Div. 21865 Copley Drive Diamond Bar, CA 91765-4182

Attn: Joan

Joan Niertit

Job No: 39762

S

LABORATORY REPORT

Samples Received: Eight (8) Liquids

Date Received: 11/04/98 Purchase Order No: 99107

The samples were analyzed as follows:

<u>Analysis</u>

Page

Nickel by ICPMS

2

Charles Jacks, Ph.D. Senior Staff Chemist D.J. Northington, Ph.D. Quality Assurance Officer

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Page 1 of 2

SOUTH COAST AIR QUALITY MANAGEMENT

Attn: Joan Niertit

Job No: 39762 November 10, 1998

LABORATORY REPORT

Nickel Quantitative Analysis Report Inductively Coupled Plasma-Mass Spectrometry

Parts Per Million (mg/L)

Sample ID	<u>Nickel</u>
Reag Bl Train #2 No Air Train #3 Air Train #4 amb Train #5 amb Train #6 No Air Train #7 Air Train #10 blk	0.025 29.5 11.7 3.08 0.35 36 13.5 0.19
Detection Limit:	0.002

Date Analyzed: 11-9-98

Quality Control Summary

Sample: Standard Reference Material USGS T111

	Certified		8	
	Value <u>ug/L</u>	Found ug/L	Acceptable <u>Error</u>	% Error
Nickel	15.5	17.8	20	14.8%

Date Analyzed: 11-9-98

This report is to be reproduced in its entirety.

Page 2 of 2

Abbreviations Summary.

General Reporting Abbreviations:

- B Blank Indicates that the compound was found in both the sample and the blank. The sample value is reported without blank subtraction. If the sample value is less than 10% the blank value times the sample dilution factor, the compound may be present as a laboratory contaminant.
- D Indicates that the sample was diluted, and consequently the surrogates were too dilute to accurately measure.
- DL Detection Limit Is the minimum value which we believe can be detected in the sample with a high degree of confidence, taking into account dilution factors and interferences. The reported detection limits are equal to or greater than Method Detection Limits (MDL) to allow for day to day and instrument to instrument variations in sensitivity.
- J Indicates that the value is an estimate.
- ND Not Detected Indicates that the compound was not found in the sample at or above the detection limit.
- ppm Parts per million (billion) in liquids is usually equivalent ppb to mg/l (ug/l), or in solids to mg/kg (ug/kg). In the gas phase it is equivalent to ul/l (ul/m³).
- Trace Indicates that the compound was observed at a value less than our normal reported Detection Limit (DL), but we feel its presence may be important to you. These values are subject to large errors and low degrees of confidence.

kg kilogram mg milligram l liter ; m meter g gram ug microgram ul microliter

OC Abbreviations:

Control QC Limits are determined from historical data. The test value must be within the Control Limits for the test warning to be considered valid. Based on historical data, the confidence intervals are 95% for warning limits and 99% for control limits.

Percent Error - This is a measure of accuracy based on the analysis of a Laboratory Control Standard (LCS). An LCS is a reference sample of known value such as an NIST Standard Reference Material (SRM). The % Error is expressed in percent as the difference between the known value and the experimental value, divided by the known value. The LCS may simply be a solution based standard which confirms calibration (ICV or CCV - initial or continuing calibration verification), or it may be a reference sample taken through preparation and analysis.

WES

13744 MONTE VISTA AVENUE · CHINO, CALIFORNIA 91710 · (909) 827-3628 · FAX (909) 627-0491

CUSTOMER	DUTH COAST AQMD		WAL NO811	0291
ATTENTION JO	OHN MCLAUGHLIN	÷	DATE RECEIVED	11/12/98
SAMPLE IDENTIFICATION		ULFATE PLATING SOL	DATE OF REPORT	11/17/98
	FOSS PLA	TING CO		
· 	TANK NO	GALLONS	SAMPLED	11/12/98
ANAL	rsis	STANDARD	RESULTS	
NICKEL NICKEL SULFATE NICKEL CHLORIC			15.7 =140	8 g/l
BORIC ACID pH SURFACE TENSIO			4.7	

·* • • .

Appendix I

SCAQMD Source Test Results California Technical Plating

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			·

SOURCE TEST REPORT

98-109, 98-110, and 98-111

Conducted at

California Technical Plating Company 11533 Bradley Avenue San Fernando, CA 91340

NICKEL EMISSIONS FROM A NICKEL ELECTROPLATING TANK WITH AND WITHOUT AIR AGITATION

TESTED:

September 3 - 11, 1998

ISSUED:

November 25, 1998

REPORTED BY:

Michael Garibay

Air Quality Engineer II

REVIEWED BY:

Edward J. Ramirez

Senior Air Quality Engineer

MONITORING AND ENGINEERING BRANCH

MONITORING AND ANALYSIS DIVISION

-2-

Dates 9/3, 9/4, & 9/11/98

BACKGROUND

a. Firm.	California Technical Plating Company
b. Test Location	. 11533 Bradley St., San Fernando, CA 91340
c. Unit Tested	Nickel Electroplating Tank
d. Test Requested by	Jill Whynot, Stationary Source . Compliance, (SSC) (909)396-3104
e. Reason for Test Request	. Develop Emission Factors for Rule 1401
f. Dates of Test	. <u>September 3, 4, & 11,1998</u>
g. Source Test Performed by	E. Ramirez .M. Garibay, G. Kasai, C. Willoughby
h. Test Arrangements Made Through	Dave Anzures, Sr. (818) 365-8205 Sam Patel, (818) 365-8205
i. Source Test Observed by	Dave Anzures, Jr. (818) 365-8205 Sam Patel, (818) 365-8205 Dennis Becvar, Pacific Environmental Services, Inc. (PES) (626) 856-1400

-3-

Dates 9/3, 9/4, & 9/11/98

<u>RESULTS</u>

Nickel Emissions from a Semi-Bright Nickel Electroplating Tank - with Air Agitation

		 			6
Run #	lb/(hr-scfm _{air})	lb/(hr-ft² _{tank})	lb/(hr-ft ² _{parts})	mg/dscm	mg/(A-hr)
1	6.33 x 10 ⁻⁶	5.51 x 10 ⁻⁶	1.42 x 10 ⁻⁵	0.059	0.264
2	7.66 x 10 ⁻⁶	6.67 x 10 ⁻⁶	1.72 x 10 ⁻⁵	0.067	0.319
3	3.89 x 10 ⁻⁶	3.46 x 10 ⁻⁶	8.92 x 10 ⁻⁶	0.035	0.171
Average	5.96 x 10 ⁻⁶	5.21 x 10 ⁻⁶	1.34 x 10 ⁻⁵	0.054	0.251
Ambient	-	-	-	1.57 x 10 ⁻³	
NI:-II T		<u>-</u>			

Nickel Emissions from a Semi-Bright Nickel Electroplating Tank - No Air Agitation

Run # lb/hr lb/(hr-ft²tank) lb/(hr-ft²pants) mg/dscm mg/(A-hr) 1 2.29×10^{-6} 1.53×10^{-7} 3.93×10^{-7} 1.57×10^{-3} 0.008 2 4.25×10^{-5} 2.83×10^{-6} 7.30×10^{-6} 2.97×10^{-2} 0.143 3 3.56×10^{-5} 2.37×10^{-6} 6.12×10^{-6} 2.45×10^{-2} 0.121 Average 2.68×10^{-5} 1.79×10^{-6} 4.60×10^{-6} 1.86×10^{-2} 0.090				T		
2 4.25×10^{-5} 2.83×10^{-6} 7.30×10^{-6} 2.97×10^{-2} 0.143 3 3.56×10^{-5} 2.37×10^{-6} 6.12×10^{-6} 2.45×10^{-2} 0.121 Average 2.68×10^{-5} 1.79×10^{-6} 4.60×10^{-6} 1.86×10^{-2} 0.090	Run #	lb/hr .	lb/(hr-ft² _{tank})	lb/(hr-ft ² parts)	mg/dscm	mg/(A-hr)
3 3.56 x 10^{-5} 2.37 x 10^{-6} 7.30 x 10^{-6} 2.97 x 10^{-2} 0.143 Average 2.68 x 10^{-5} 1.79 x 10^{-6} 4.60 x 10^{-6} 1.86 x 10^{-2} 0.090	1	2.29 x 10 ⁻⁶	1.53 x 10 ⁻⁷	3.93 x 10 ⁻⁷	1.57 x 10 ⁻³	0.008
Average 2.68×10^{-5} 2.37×10^{-6} 2.45×10^{-2} 0.121 4.60×10^{-6} 1.86×10^{-2} 0.090	2	4.25 x 10 ⁻⁵	2.83 x 10 ⁻⁶	7.30 x 10 ⁻⁶	2.97 x 10 ⁻²	0.143
$\frac{1.75 \times 10^{-2}}{4.60 \times 10^{-2}} = \frac{1.86 \times 10^{-2}}{0.090}$	3	3.56 x 10 ⁻⁵	2.37 x 10 ⁻⁶	6.12 x 10 ⁻⁶	2.45 x 10 ⁻²	0.121
	Average	2.68 x 10 ⁻⁵	1.79 x 10 ⁻⁶	4.60 x 10 ⁻⁶	1.86 x 10 ⁻²	0.090
Ambient - 8.38 x 10 ⁻⁴ -	Ambient		•	-	8.38 x 10 ⁻⁴	-

-4-

Dates 9/3, 9/4, & 9/11/98

INTRODUCTION

The South Coast Air Quality Management District (SCAQMD), is attempting to gather information on nickel, hydrogen chloride, and sodium hydroxide emissions from plating and metal treating processing from nickel plating facilities. The testing was requested to provide improved data on emissions from these operations and address unresolved issues under SCAQMD Rule 1401.

Previous testing conducted by the Metal Finishing Association of Southern California (MFASC) and the California Air Resources Board (CARB) consisted of triplicate tests for nickel from nickel electroplating. The current testing is intended to resolve issues raised during the review of the MFASC test regarding high levels of background nickel and potential fugitive losses. The testing is also intended to evaluate the representativeness of existing emission factors. The scope of the current testing effort has been expanded to measure nickel emissions from electroless nickel plating operations, hydrogen chloride from metal acid treating tanks and sodium hydroxide from metal treating tanks at nickel plating facilities. This test report, which is part of the series of tests intended to collect this information, reports emissions from a nickel electroplating tank with and without air agitation. The complete testing series in the project consist of SCAQMD Source Tests: 98-105, 98-106, 98-107, 98-108, 98-109, 98-110, and 98-111.

The test plan was developed via a cooperative effort with the SCAQMD and MFASC. This test report incorporates and addresses comments from representatives from both the SCAQMD and MFASC during weekly meetings from the projects beginning to end. The testing was conducted at a volunteer MFASC member facility with excellent building ventilation so as to avoid background interference. The sampling was conducted by SCAQMD Methods and Testing staff. The analysis was conducted by the SCAQMD laboratory and SCAQMD contractor.

The testing consisted of two sets of triplicate two hour sampling runs with one set run under the air agitation operating condition and the second set run without the air agitation. The results are reported in units of milligrams nickel per plating amperage plating elapsed time (mg/A-hr), as well as other units. The results of the testing are intended to be used as emissions factors in health risk exposure assessments. As with other types of plating processes, the emissions are reported on a per ampere-hour basis so that ampere hour data commonly collected in the industry can be used to track the total mass emissions.

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Dates 9/3, 9/4, & 9/11/98

PROCESS DESCRIPTION

Background

In the plating industry, nickel plating is employed as a decorative and/or protective layer over a variety of metal pieces. The nickel plating can be used as a final finish or covered with a thin plating of chromium as with decorative chrome applications. The nickel plating can be conducted using electrodes and electromotive force or using an electroless process. Emissions are produced as small droplets of the solution in aerosol form due to bubbling in the tanks caused by electrolysis or other processes such as air agitation commonly employed to enhance the plating process.

In the electrolytic plating process, the parts are immersed in an acidic solution with ionic nickel where a current is applied so that solid nickel is plated onto the parts. An immersion heater can be employed in the plating tanks to maintain a desired plating bath temperature. This type of plating employs a surface tension reducing agent to reduce the surface tension to approximately 35 dynes/cm for purposes of minimizing pitting in the plating process. The solutions within the tanks are agitated by pump recirculation or by bubbling with air. Either a bright or semi-bright plated finish can be accomplished depending on the additives in the plating solution. The tanks are equipped with rectifiers to produce a low voltage high amperage DC current. According to the Lawrence J. Durney, Electroplating Engineering Handbook, the metal parts are plated with a current density of 20 - 50 amperes per square foot of plating surface area. The majority of the existing nickel electroplating tanks are not vented by a dedicated ventilation system. The buildings that house these processes, typically employ some type of ventilation system which may be forced draft, natural draft, or cross draft in nature.

For the electroless nickel plating, the plating is driven by difference in electropotential. The solution differs from the electroplating solution to enhance this process. For electroless applications, since the solutions contain odiferous compounds such as ammonia, the plating tanks typically include ventilation systems at a close proximity above the plating tanks to draw emissions from the plating tanks out of the work space.

-6-

Dates 9/3, 9/4, & 9/11/98

The nickel platers also employ both hydrochloric acid and sodium hydroxide metal treating processes. The hydrochloric acid process is an etching process in which bubbling occurs due to gasses produced as the metal is etched. The sodium hydroxide process can be employed by spraying, electrocleaning, etching (for aluminum), or soak cleaning with a detergent. Of the sodium hydroxide processes, the soak cleaning is expected to produce the least amount of emissions, while the spraying is expected to produce the highest.

Nickel Plating Operation During Testing

During testing, the nickel electroplating tank was operated during active plating for the entire test period excluding a brief period where the parts were removed to simulate dragout effects. Dummy parts were used as a plating substrate as shown in Figure 1. The host facility requested that the rectifier not be operated above 150 amperes due to potential over-heating of the rectifier. The dummy parts were sized so that a plating current density of approximately 20 amperes per square foot was obtained at below 150 amperes total current. This current density was chosen so as to be as consistent as possible with the past MFASC testing current density of 17 amperes per square foot while also keeping in the 20-50 A/ft² range of normal nickel plating as specified in the Electroplating Engineering Handbook. Since the parts were not entirely submerged in the plating solution the actual current density applied was calculated using the resulting plated surface area. As with the past MFASC testing, the dummy parts were lifted out and replaced back into the solution six times during each sampling run, to simulate dragout and disturbance of the solution surface during normal operation. The tank was equipped with a circulation pump and filter as well as a parts agitator which moves the parts in a linear cyclical manner. The parts agitator was operated during the non-air agitated tests only to maintain normal operation under both air and non-air agitated conditions. Photographs of the host plating tank and the surface of the solution both with and without air agitation are shown in Figures 2, 3, and 4. The following are the specifications of the nickel plating tank and the lists of operating conditions that were monitored during each of the test runs:

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Tank Dimensions	Rectifier Rated Capacity	Type of Plating
36"W x 60"L x 48"H	500 amperes	Semi-Bright Nickel
		DOME DIENT INICKEL

Operating Conditions Recorded During Testing - Air Agitation Run #1

Freeboard Height Plating Solution Temperature Plating Solution Nickel Content Plating Solution Boric Acid Content Plating Solution pH Plating Solution Surface Tension Plating Solution Specific Gravity Plating Voltage Average Amperage Applied Calculated Ampere-hour Usage Calculated Current Density Number of Dummy Parts Total Surface Area of Plated Parts Plating Period within Test Run Duration of Test Runs Capture Efficiency of Ventilation System Ventilation Rate Air Agitation Rate	4 121 10.3 5.0 3.5 37.9 1.27 6.5 142 284 24.4 4 5.82 120 120 100 422 13.0	oz/gal pH
Ventilation Rate	422	% acfm

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Operating Conditions Recorded During Testing - Air Agitation Run #2

	4	inches
Freeboard Height	119	°F
Plating Solution Temperature		_
Plating Solution Nickel Content	10.3	oz/gal
Plating Solution Boric Acid Content	5.0	oz/gal
Plating Solution pH	3.5	pН
Plating Solution Surface Tension	37.9	dynes/cm
Plating Solution Specific Gravity	1.27	·#
Plating Voltage	6.5	volts
Average Amperage Applied	142	amperes
Calculated Ampere-hour Usage	284	A-hr
Calculated Current Density	24.4	A/ft²
Number of Dummy Parts	4	plates
Total Surface Area of Plated Parts	5.82	
Plating Period within Test Run	120	
Duration of Test Runs	120	min /test run
Capture Efficiency of Ventilation System	100	%
Ventilation Rate	452	acfm
Air Agitation Rate	13.0	scfm
Air Agitation Rate per unit solution surface area	0.87	scfm/ft ²
Part Agitation Rate	0	in/min
Solution Circulation Rate	5 - 7	gpm (estimated)

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Operating Conditions Recorded During Testing - Air Agitation Run #3

Freeboard Height		
Plating Solution Temperature	4	inches
Plating Solution Nickel Content	120	°F
Plating Solution Boric Acid Content	10.3	oz/gal
Plating Solution pH	5.0	oz/gal
	3.5	pΗ
Plating Solution Surface Tension	37.9	dynes/cm
Plating Solution Specific Gravity	1.27	•
Plating Voltage	6.0	volts
Average Amperage Applied	138	amperes
Calculated Ampere-hour Usage	276	A-hr
Calculated Current Density		A/ft ²
Number of Dummy Parts	4	plates
Total Surface Area of Plated Parts	5.82	ft ²
Plating Period within Test Run		
Duration of Test Runs	120	min / test run
Capture Efficiency of Ventilation System	120	min /test run
Ventilation Rate	100	%
Air Agitation Rate	433	acfm
	13.4	scfm
Air Agitation Rate per unit solution surface area	0.89	scfm/ft ²
Part Agitation Rate	0	in/min
Solution Circulation Rate	5 - 7	gpm (estimated)
		<i>S</i> 1 (

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Operating Conditions Recorded During Testing - No Air Agitation Run #1

	4 [.]	inches
Freeboard Height	124	°F
Plating Solution Temperature	10.3	<u>-</u>
Plating Solution Nickel Content	5.0	oz/gal
Plating Solution Boric Acid Content		_
Plating Solution pH	3.5	pH
Plating Solution Surface Tension	37.9	dynes/cm
Plating Solution Specific Gravity	1.27	±
Plating Voltage	6.0	volts
Average Amperage Applied	138	
Calculated Ampere-hour Usage	276	_
Calculated Current Density	23.7	A/ft²
Number of Dummy Parts	4	plates
Total Surface Area of Plated Parts	5.82	ft ²
Plating Period within Test Run	120	min / test run
Duration of Test Runs	120	min /test run
Capture Efficiency of Ventilation System	100	%
Ventilation Rate	431	acfm
	0	scfm
Air Agitation Rate	0	scfm/ft ²
Air Agitation Rate per unit solution surface area	77	in/min
Part Agitation Rate	5 - 7	
Solution Circulation Rate	,	or*** (*********************************

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Operating Conditions Recorded During Testing - No Air Agitation Run #2

Freeboard Height	4	inches
Plating Solution Temperature	123	°F
Plating Solution Nickel Content	10.3	oz/gal
Plating Solution Boric Acid Content	5.0	oz/gal
Plating Solution pH	3.5	pH
Plating Solution Surface Tension	37.9	dynes/cm
Plating Solution Specific Gravity	1.27	dynes/em
Plating Voltage	6.6	volts
Average Amperage Applied	135	amperes
Calculated Ampere-hour Usage	270	A-hr
Calculated Current Density	23.2	A/ft²
Number of Dummy Parts	4	plates
Total Surface Area of Plated Parts	5.82	ft ²
Plating Period within Test Run	120	min / test run
Duration of Test Runs	120	min /test run
Capture Efficiency of Ventilation System	100	%
Ventilation Rate	425	acfm
Air Agitation Rate	0	scfm
Air Agitation Rate per unit solution surface area	0	scfm/ft ²
Part Agitation Rate	77	
Solution Circulation Rate		in/min
	5 - 7	gpm (estimated)

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Operating Conditions Recorded During Testing - No Air Agitation Run #3

	4	inches
Freeboard Height	122	°F
Plating Solution Temperature	10.3	oz/gal
Plating Solution Nickel Content	5.0	oz/gal
Plating Solution Boric Acid Content	3.5	pН
Plating Solution pH	37.9	
Plating Solution Surface Tension	1.27	•
Plating Solution Specific Gravity	6.6	volts
Plating Voltage	134	amperes
Average Amperage Applied	268	A-hr
Calculated Ampere-hour Usage	23.0	A/ft ²
Calculated Current Density	4	plates
Number of Dummy Parts	5.82	- n
Total Surface Area of Plated Parts	120	
Plating Period within Test Run	120	
Duration of Test Runs	100	
Capture Efficiency of Ventilation System	430	acfm
Ventilation Rate	0	scfm
Air Agitation Rate	0	scfm/ft ²
Air Agitation Rate per unit solution surface area	77	in/min
Part Agitation Rate	5 - 7	
Solution Circulation Rate	<i>J</i> - 1	BPE (SOCIETY

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TESTING METHODOLOGY

The testing consisted of two sets of triplicate two hour sampling runs with one set run under the air agitation operating condition and the second set run without the air agitation. The applied amperage during plating was obtained from a calibrated ammeter. The calibration certificate is included in the Appendix. The accuracy of the ammeter was checked by two means. A portable electrician's ammeter was used to verify the amperage at the rectifier. The resulting plating thickness was also checked by Mr. Sam Patel of California Technical Plating and verified to be that of the calculated resulting thickness for the plating time and amperage that were applied.

A temporary reduced draft ventilation system was designed and constructed both to isolate the process and collect the resulting nickel emissions in a manner to both facilitate the emissions measurement and to address concerns by the MFASC. The main MFASC concern is that a high flow ventilation system, such as a dedicated side-draft ventilation system may produce higher emissions due to entrainment of large splashed droplets that potentially fall back into the tanks or to the ground and may not become emissions to the atmosphere.

The temporary reduced draft system is designed to simulate emissions to the atmosphere of an unventilated tank. Mass emissions collected in the duct of a ventilated tank may be higher due to this effect. The temporary ventilation system consisted of cube shaped hood of similar cross sectional dimensions of the host tank. The hood was vented to a small blower which was set to achieve a specific velocity vertically through the hood. The hood was suspended at a height above the tank so that air also entered the hood from the space between the hood and the tank at a specified velocity. The height of the hood was 1.4 times the equivalent diameter of the tank cross section. A straight run of ducting between the hood and the blower was used to isolate and measure the emissions from the tank. A schematic of this system is shown in Figure 5. A photograph of the hood connected to the host tank is shown in Figure 6.

The appropriateness of the hood height was determined by a small scale 16"W x 20"L x 25"H hood connected to a small blower to simulate the full scale design. At a ventilation rate of 50 ft/min as determined by a calibrated vane anemometer, the height of the hood

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was sufficient to create a uniform velocity over the lower cross-section of the hood and maintain this uniformity for the lower one third of the hood. This was done to ensure that no high or low velocity zones were present as to defeat the purpose of the hood in its lower section.

As discussed in meetings with SCAQMD Methods and Testing staff and MFASC, the specific velocity was chosen to be approximately 50 ft/min. This specific velocity was chosen for the following reasons:

- 1. The velocity is considered as the minimum velocity at which 100% capture of actual emissions to the atmosphere can be achieved. This was verified using the small scale capture hood and a smoke test.
- 2. The velocity is sufficiently low as to not overestimate the range of velocities that may be encountered in a building that houses the process. This is important since these internal air currents are responsible for transporting the emissions to the atmosphere. For purposes of comparison, 50 ft/min equates to 0.57 miles per hour. Assuming that outdoor wind speeds typically vary from 3 -10 mph, it is not unreasonable to assume that 0.57 mph indoor air movements can be induced either by open doors, or the building's ventilation system.
- 3. According to the American Conference of Governmental Industrial Hygienist Industrial Ventilation Manual, 50 fpm is the indoor air speed created by an effective air conditioning system.
- 4. Calculations of settling velocity of small aerosols shows that small aerosol droplets less than 10 microns in diameter are capable of remaining airborne for several minutes, and much longer in moving air.
- 5. Past testing for cadmium emission factor has been successfully employed using a similar capture velocity.

Two large doors on the southwest side of the building provided a continuous stream of clean outside air to the tank area. The exhaust from the hood was directed towards a building ventilation blower so that the nickel was swept from the building to avoid the affects of hood exhaust recirculation. This air flow path was verified by smoke test.

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SAMPLING AND ANALYTICAL PROCEDURES

Flow Rate

The gas velocity within the sampling duct was measured during each sampling run at eight points within the duct cross section according to SCAQMD Methods 1.2 and 2.3. This was performed simultaneously with the pollutant sampling using a NIST traceable standard type Pitot tube with a differential pressure manometer, and a type "K" thermocouple with a potentiometer (Figure 7). The apparatus was checked for leaks both before and after use by introducing a pressure head and blocking the flow at the Pitot tip. An observation of the resulting stabilization in pressure at the manometer verified the absence of leaks in the system. The stack's access ports were located using the approach of SCAQMD Method 2.3 for ducts of less than 12 inches in diameter. Using this approach, the sampling access ports were located approximately eight stack diameters downstream and greater than two stack diameters upstream from flow disturbances. The velocity access ports were located approximately five stack diameters downstream from the sampling access ports and greater than two stack diameters upstream from a flow disturbance. This configuration meets the minimum and most of the preferred SCAQMD Method 1.2 requirements for measurement site location.

A cyclonic flow check was also performed to check for the presence of flow that is non-parallel to the duct wall which can cause a bias in the flow measurement. This was accomplished by rotating an S-type Pitot tube at each traverse point until a zero pressure differential results at the gauge. The null angle is determined with an inclinometer as the deviation of the Pitot angle with respect to a plane perpendicular to the theoretically straight duct flow. Data from the cyclonic flow check shows that the duct does not exhibit cyclonic flow as defined in Method 1.1.

The volumetric flow rate was calculated for each sampling run using the stack's cross sectional area and average gas velocity. The flow rate was corrected to standard conditions by using the stack temperature and pressure along with the barometric pressure measured with a calibrated aneroid barometer. The flow rate was also corrected to dry conditions using the moisture content as determined by the SCAQMD Method 4.1 weight gain from the nickel sampling train as described in the following section.

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Nickel Sampling - Modified CARB Method 433

A nickel sample was collected during each sampling run using Modified CARB Method 433. The modification was the same as that employed by MFASC contractor, PES, which consists of the use of a back-up filter as opposed to the up-front heated filter.

The sample was collected from the locations within the sampling duct previously described in the velocity measurements. Each sample was collected over a period of 120 minutes using a sampling train consisting of a glass probe and nozzle connected by a six to eight foot length of non-reactive tubing to the first of two Greenburg-Smith impingers each containing 100 ml of 0.1N nitric acid solution, an empty bubbler, a 0.5 micron glass fiber back-up filter, and a bubbler containing tared silica gel desiccant.

The impinger assembly was connected to a vacuum pump and a calibrated dry gas meter as shown in Figure 8. The sampling apparatus was checked for leaks both before and after sampling by blocking the flow at the probe tip. An observation of the resulting decrease in flow at the meter to less than 0.02 cfm or four percent of the sampling rate indicated an acceptable leak rate. The impinger train was contained within an ice bath to condense water and other condensable matter present in the sample stream.

The impinger train was returned to the SCAQMD laboratory for recovery. The recovered solutions were dissolved in concentrated nitric acid and boiled down according to CARB Method 433 and sent to West Coast Analytical Service, Inc. For analysis. Nickel collected in the nozzle, probe, impingers, and filter was determined using CARB Method 433 by Inductively Coupled Plasma Mass Spectrometry (ICPMS).

At the request of the MFASC, ambient sampling within the plating facility was conducted. The ambient samples were collected using the same configuration and analysis as that used for emissions sampling. The ambient samples were collected at a distance of approximately eight feet from the plating tank in the upwind direction with respect to airflow in the building at approximately the same height that the air entered the collection hood. The first ambient sample represents composite sampling of the ambient air during the air agitation runs and during the first of the non-air agitation runs. The second ambient sample represents composite sampling of the ambient air during the second two non-air agitation runs. A blank field sample train was also analyzed as above for quality control purposes.

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Capture Efficiency

The capture efficiency was determined by a smoke test. The smoke test was accomplished using titanium chloride smoke generating tubes. This technique can be used to verify 100% capture or conversely less than 100% capture by observing the flow of the smoke into the capture hood. The observation of complete capture of the smoke indicated 100% capture efficiency. The smoke test was conducted at the perimeter of the tank between the temporary capture hood and the tank. Photographs of the actual smoke test are shown in Figure 9.

The height of the capture hood and the ventilation rates were adjusted in an attempt to achieve the 50 ft/min specified velocity vertically within the hood as well as to the sides of the hood. The actual velocities that were achieved during each sampling run were calculated from the ventilation flow rate and the cross sectional areas. The results of these calculations are presented in the following table:

Run #	Vent Velocity (fps)	Vertical Velocity in Hood (fpm)	Horizontal Velocity Between Hood and Tank (fpm)
Run #1 with Air	26.33	38.0	49.0
Run #2 with Air	28.18	40.6	52,4
Run #3 with Air	26.98	38.9	50.2
Run #1 no Air	26.86	38.7	50.0
Run #2 no Air	26.52	38.2	49.3
Run #3 no Air	26.83	38.7	49.9

Where:

Vent Cross Section (7.0" diameter) = 0.267 ft^2

Hood Cross Section (40" x 40")= 11.11 ft^2

Gap Cross Section (7.75" between hood and tank) = 8.61 ft^2

Vertical Velocity = Vent Velocity x 60 s/min x Vent Cross Section / Hood Cross Section Horizontal Velocity = Vent Vel. x 60 s/min x Vent Cross Section / Gap Cross Section

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Air Agitation Rate

In order to achieve the desired air agitation rate of 0.83 acfm/ft²_{tank}, the air agitation valve was adjusted and the air agitation checked. This was repeated until the desired air agitation rate was achieved. This desired air agitation rate was then visually verified to be similar to that of the past MFASC testing by Mr. Dennis Becvar of PES who was present at both testing events.

To measure the air agitation rate, a five gallon plastic bucket was inverted and submerged to approximately one third of its height into the plating solution to create an air-tight seal at the bucket's perimeter. The bucket was moved across the surface of plating bath as to encompass the average air agitation rate in the tank while maintaining the bucket at a constant submersion height. A tap on the unsubmerged side of the bucket was connected to a calibrated gas meter to measure the volume of air collected in the bucket during which the elapsed time was also recorded. This technique was checked for accuracy in the laboratory by bubbling a known amount of air into the bottom of a water bath. The bucket technique was successful in duplicating the measurement of the gas metered into the bottom of the tank.

The air agitation rate as determined by this method was reported in units of scfm. Since a 60°F temperature compensated meter was used at atmospheric pressure, the readings were taken at very close to standard conditions. The moisture in the tank was, for the most part, condensed in the line between the bucket and the meter. A residual moisture, however, of approximately 2 - 5% remained in the metered air as it passed through the line. For this reason, the air agitation rate was not reported as a dry flow rate.

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TEST CRITIQUE

The test was conducted under operating conditions so that the conditions of the past MFASC testing could be duplicated. A comparison to key operational parameters to the past MFASC testing are shown in the table below. It is assumed that these parameters were chosen by the MFASC to be representative of the nickel plating applications for which the emission factors are intended to be applied.

D D		
Process Parameter	MFASC Test	SCAQMD Test
Plating Current Density	17 amperes/ft ² parts	24 amperes/ft ² parts
Air Agitation Rate	0.83 acfm/ft ² tank	0.88 acfm/ft ² tank
	as measured by PES	as measured by SCAOMD
Plating Solution	137-145 °F	119-123 °F
Temperature		
Plating Solution Nickel	10.3 - 12.6 oz/gal	10.4 oz/gal
Content	C]
Plating Solution Boric Acid	5.8 - 8.3 oz/gal	7.6 oz/gal
Content		3-2
Plating Solution pH	3.4 - 4.3	2.0
Plating Solution Surface	34.2 - 35.9 dynes/cm	37.9 dynes/cm
Tension		, , , , ,
Number of Drag-Out Events	6	6
per Run		
Duration of Test Runs	120 min	120 min

The emissions for the air agitation runs were 3 times higher than the emissions without air agitation. The increase in measured emissions from the air agitated condition as compared to non-air agitated, is consistent with observations of the emissions characteristics of each condition. This difference in the emissions characteristics are consistent with the following observations comparing the agitated and non-agitated conditions:

1. Non-air agitated nickel plating has been observed to exhibit very little bubbling during plating due to a high efficiency of converting current to plating. This differs from chrome plating, where much bubbling is typically observed due to lower plating efficiency where much of the electrical current causes electrolysis of the plating

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solution. As compared to the non-air agitated condition, the air agitation provides a great deal of turbulence to cause the formation of solution aerosol droplets. The difference between the two operating conditions is demonstrated in Figures 3 and 4.

- 2. A green nickel residue in the areas surrounding nickel plating tanks has been observed as accumulation in the facilities that employ air agitation. This residue has been observed within a large perimeter surrounding the plating tanks as well as high in the building on overhead pipes and ducting. This suggests that the aerosol droplets created by the air agitation can be sufficiently small so that they can be transported away from the immediate area of the tanks. Conversely, very little of this residue was observed at facilities that do not typically employ air agitation.
- 3. During testing it was observed that a burning sensation was experienced in the throat when breathing the blower effluent during air agitation. This observation was due to the acidic effects of the nickel plating solution on the throat while breathing. This observation did not occur when breathing the blower effluent during the non-air agitated condition. This indicates that a great deal more plating solution becomes airborne during air agitation.

Since the parts were not entirely submerged in the plating solution, the actual applied current density was calculated using the resulting plated surface area. Although the resulting current density of 23.0 - 24.4 A/ft² is higher than the target current density of 20 A/ft², it remains within the lower portion of the 20 - 50 A/ft² range specified as normal nickel plating in the *Electroplating Engineering Handbook*.

The measured ambient concentration for the air agitated condition was less than three percent of that measured for emissions sampling. The blank sample detection was 67% less than that detected in the ambient sample. The contribution of the blank and the ambient are therefore considered as insignificant for the sampling with air agitation.

For the air agitated condition, the precision of the sampling as indicated by the consistency of the triplicate sampling results is well within that which is generally experienced and considered acceptable for this type of sampling. For the non-air agitated condition, however, the precision of the sampling as indicated by the consistency of the triplicate sampling results is not within that which is generally considered acceptable for this type of sampling.

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CONCLUSION

The results of the test during air agitation are considered as both sufficiently accurate and precise for use in determining nickel emission factors. The increase in measured emissions from the air agitated as compared to those measured during the non-air agitated condition is consistent with observations of the emissions characteristics of each condition. The results of the non-air agitation test, however, are considered to be less precise due to poor reproducibility of the triplicate runs.

Unlike the other tests in this project, a recommendation on the emission factor in which units would best represent actual emissions will not be made for this report. The reason for this is that, at the time of this report's issue, further testing is taking place. This additional testing is designed to address the precision problems and provide confirmation of the previous testing. Some guidance, however, is given as follows:

If the lb/hr-ft²_{tank} factor is used, emissions would be determined by multiplying the factor by ft²_{tank} as determined using the horizontal internal dimensions of a given tank, and also multiplied by the hours of air agitation for emissions during a specified time period. It is suggested that this factor is not well suited for non-air agitation applications due to the mechanism for the emissions being relatively independent of tank surface area.

If the lb/hr-ft²_{parts} factor is used, emissions would be determined by multiplying the factor by ft²_{parts} as determined using the average total surface of parts that are plated in the tank, and also multiplied by the hours of plating during a specified time period. It is suggested that this factor is not well suited for air agitation applications due to the mechanism for the emissions being relatively independent of part surface area.

If the lb/hr-scfm_{air} factor is used, emissions would be determined by multiplying the factor by scfm of air agitation and also multiplied by the hours of air agitation for emissions during a specified time period. If the bucket method is used to determine the air agitation rate, the scfm/ft²_{tank} result would be multiplied by the ft²_{tank} as determined using the horizontal internal dimensions of a given tank to determine scfm_{air}. This factor would not be appropriate for non-air agitation applications.

The emission factors will not represent emissions from tanks that do not use a surface tension reducing agent that reduces to the 38.9 dyne/cm level encountered in this testing.

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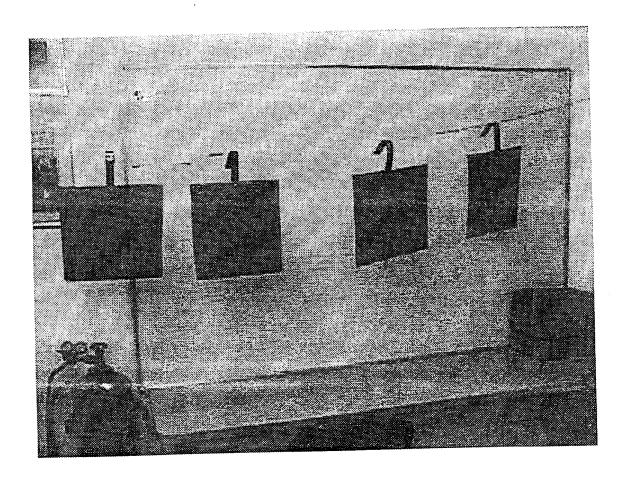


Figure 1 - Photograph of Dummy Parts

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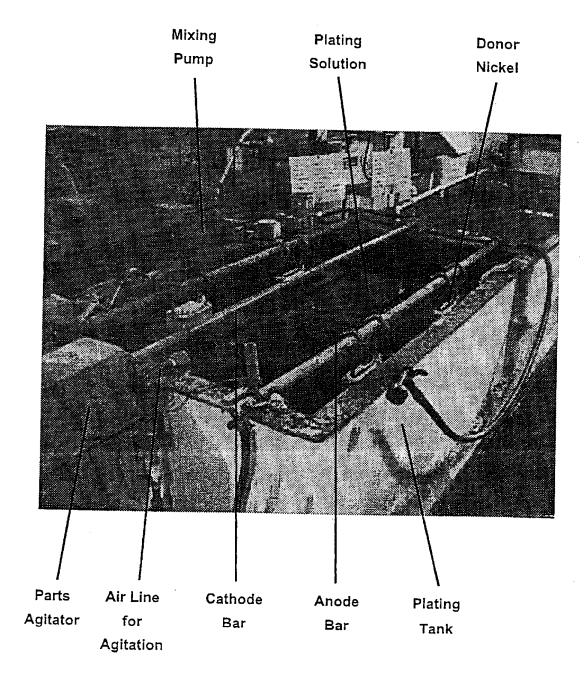


Figure 2 - Photograph of Host Nickel Plating Tank

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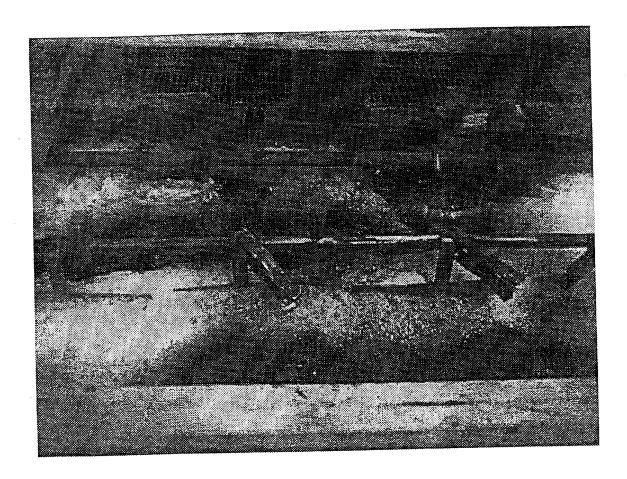


Figure 3 - Photograph of Active Plating Surface with Air Agitation

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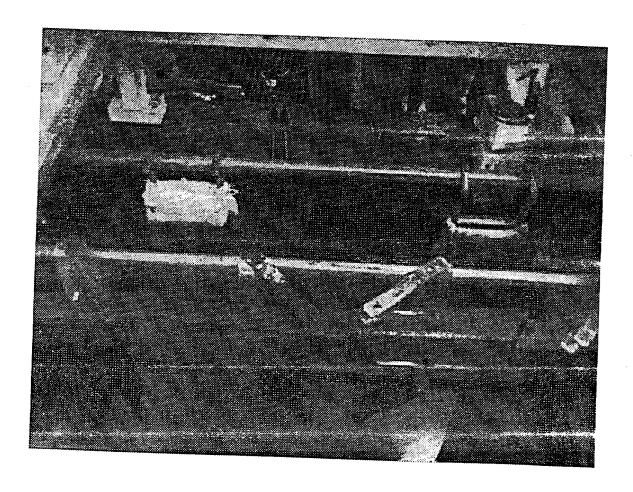


Figure 4 - Photograph of Active Plating Without Air Agitation

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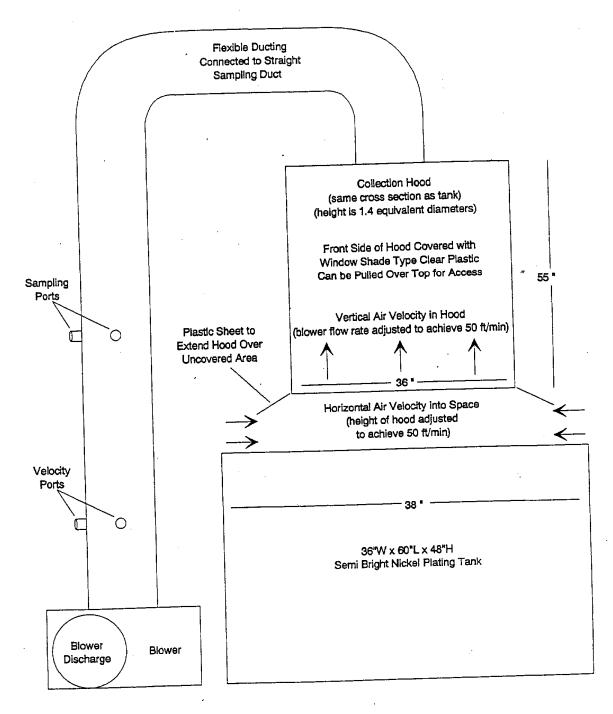


Figure 5 - Temporary Ventilation System with Sampling Location

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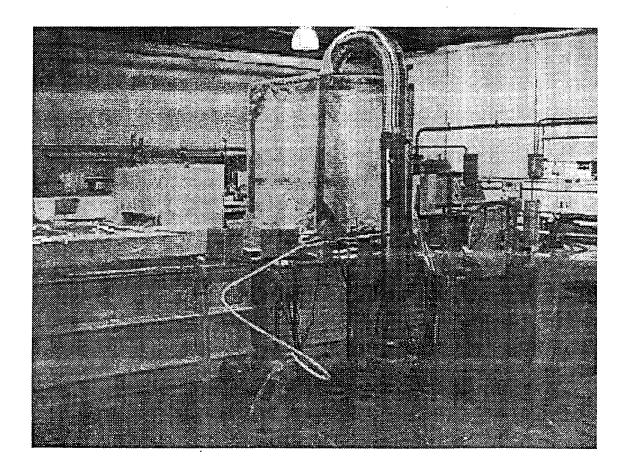
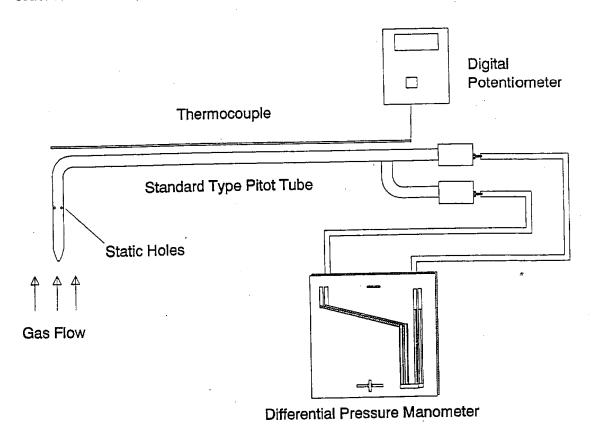


Figure 6 - Photograph of Temporary Ventilation System with Sampling Location

Diameter 7 in

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5
6
7
1 2 3 4
1 2 3 4
2 6 1.75
3,7 5.25
7 4,8 6.5

Distance from Inner Stack Wall (in)
0.5
1,5
6.5

Figure 7 - Flow Rate Measuring Apparatus

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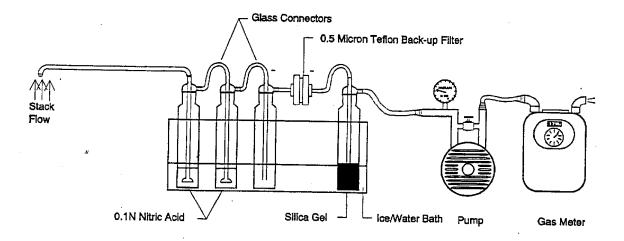


Figure 8 - Nickel Sampling Apparatus

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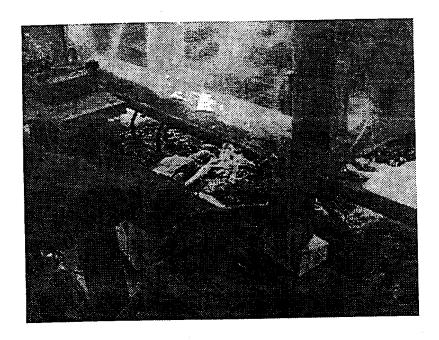




Figure 9 - Photographs of Smoke Test for Capture Efficiency

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SOURCE TEST CALCULATIONS

Average Velocity and Temperature

Run #1 with Air Agitation

Traverse Point#	Velocity Head #1 ("H ₂ O)	Temp. (°F)	Calculated Velocity (fps)			
1 2 3 4 5 6 7 8	0.10 0.14 0.15 0.15 0.15 0.14 0.15 0.16	95 95 92 90 91 91 90	21.60 25.56 26.39 26.34 26.36 25.47 26.34 27.20			
Average Velocity (fps) 25.66						
Average Te	mperature	(°F) -	91.75			

Run #2 with Air Agitation

Traverse Point #	Velocity Head #1 ("H₂O)	Temp.	Calculated Velocity (fps)				
1 2 3 4 5 6 7 8	0.14 0.19 0.16 0.18 0.14 0.18 0.15 0.17	90 91 90 90 90 90 90 89	25.45 29.67 27.20 28.85 25.45 28.85 26.34 28.02				
Average Velocity (fps) 27.48							
Average Temperature (°F) - 90							

Where: Calculated Velocity = $2.9 \times [Velocity Head \times (460 + Temperature)]^{0.5}$

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SOURCE TEST CALCULATIONS

Average Velocity and Temperature

Run #3 with Air Agitation

Traverse Point#	Velocity Head #1 ("H₂O)	Temp. (°F)	Calculated Velocity (fps)				
1	0.14	81	27.01				
2	0.16	82	1 1				
3	0.18	82	28.64				
4	0.14	81	25.24				
5	0.14	80	25.21				
1 6	0.17	81	27.81				
1 7	0.16	81	26.98				
8	0.14	80	25.21				
1		<u> </u>	1				
Average \	elocity (fps	i)	26.42				
Average T	Average Temperature (°F) - 81						

Run #1 No Air Agitation

Traverse Point#	Velocity Head #1 ("H₂O)	Temp. (°F)	Calculated Velocity (fps)			
1	0.17	83	27.86			
2	0.16	80	26.96			
3	0.14	83	25.28			
4	0.12	80	23.34			
5	0.14	80	25.21			
6	0.16	83	27.03			
7	0.16	82	27.01			
8	0.17	83	27.86			
•		l				
Average Velocity (fps) 26.32						
Average Temperature (°F) - 81.75						

Where: Calculated Velocity = $2.9 \times [Velocity Head \times (460 + Temperature)]^{0.5}$

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Dates 9/3, 9/4, & 9/11/98

SOURCE TEST CALCULATIONS

Average Velocity and Temperature

Run #2 No Air Agitation

Traverse Point#	Velocity Head #1 ("H₂O)	Temp. (°F)	Calculated Velocity (fps)					
1 2 3 4 5 6 7 8	0.12 0.14 0.18 0.16 0.13 0.15 0.15	90 91 90 90 89 90 90	23.56 25.47 28.85 27.20 24.50 26.34 26.34 25.47					
Average V	Average Velocity (fps) 25,97							
Average Te	mperature	(°F) -	90.125					

Run #3 No Air Agitation

Traverse Point#	Velocity Head #1 ("H₂O)	Temp.	Calculated Velocity (fps)
1	0.11	90	22.56
2	0.14	90	25.45
3	0.16	90	27.20
4	0.21	89	31.14
5	0.11	89	22.54
6	0.16	89	27.18
7	0.16	87	27.13
8	0.16	85	27.08
Average Ve	locity (fos)		26.28
			∠0.∠0
Average Te	mperature	<u>(T)</u>	88.625

Where: Calculated Velocity = $2.9 \times [Velocity Head \times (460 + Temperature)]^{0.5}$

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Dates 9/3, 9/4, & 9/11/98

SOURCE TEST CALCULATIONS Flow Rate and Emissions for Run #1 with Air Agitation

Sample Train:	vickel Train #5				nput by: M.	Garibay	
SUMMARY A. Average Traverse V B. Gas Meter Tempera C. Gas Meter Correctio D. Average Orifice Pre E. Nozzle Diameter	ture (Use 50 deg.F fo n Factor	ir Temp Comp				25.66 1 100.3 0 1.0042 2.04 0.3212	deg F "H20
F1. Stack Dimension # F2. Stack Dimension # G. Stack Cross Sect. A H. Average Stack Tem I. Barometric Pressure J. Gas Meter Pressure K. Static Pressure L. Total Stack Pressur T. Corrected Gas Volu	2	ft2 if deg F (if the control of the	M. Pitot Corre N. Sampling T D. Nozzle X-S P. Sample Co Q. Sample Co R. Water Vap S. Gas Volum	Time Sect. Area. bilection ollection bor Conder ne Metered	sed	1.00 120 0.00056 0.153 0.153 56.3 101.067 90.823	ft mg mg ml def #
PERCENT MOISTUR U. Percent Water Var		4,64 x R)/((0.0)464 x R) + T	`)) _		2.80	%
V. Average Molecula	tr Weight (Wet):						
Component	Vol. Fract.	x Moist	ract.	x N	lolecular Wt	: =	
Water Carbon Dioxide Carbon Monoxide Oxygen Nitrogen & Inerts	0.028 0.000 Dry Basi 0.000 Dry Basi 0.209 Dry Basi 0.791 Dry Basi	s 0.972 s 0.972		18.0 44.0 28.0 32.0 28.2	Sum	0.50 0.02 0.00 6.50 21.67	
FLOW RATE W. Gas Density Corr X. Velocity Pressure Y. Corrected Velocit Z. Flow Rate (Y x G AA. Flow Rate (Standard) BB. Dry Flow Rate (A	Correction Factor (2 y (A x M x W x X) x 60)dard) (Z x (L/29.92) x AA x (U/100))	9.92/L)^.5 : [520/(460+H))]}			422 381	
SAMPLE CONCENT CC. Sample Concen DD. Sample Conc. [4 EE. Nickel Emission FF. Nickel Emission GG. Isokinetic Samp	tration [0.01543 x (P. 54,143xCC/ 5	/T)] 8.7 (Molecula xCC) x BB//Tl	ir vvt.)j		······································	0.0239 8.26E-0 8.25E-0	5 lb/hr



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Dates 9/3, 9/4, & 9/11/98

SOURCE TEST CALCULATIONS Flow Rate and Emissions for Run #2 with Air Agitation

Sample Train:	Nickel Train #14			Input by	y: M.Garibay	
SUMMARY				,	·	
	Malasia.					
A. Average Traverse	velocity			• • • • • • • • • • • • • • • • • • • •	27.48 fps	
B. Gas Meter Temper	ature (Use 60 deg.F	for Temp Co	mp. Meters)		102.8 deg	F
C. Gas Meter Correcti	on Factor				4.0040	
D. Average Unnice Pr	essure				242 8104	5
E. Nozzle Diameter				••••••••••••	0.3125 inch	
F1. Stack Dimension i	¥1	7 inch				
F2. Stack Dimension #	£2	inch	M. Pitot Correction	on Factor	. 1.00	
G. Stack Cross Sect. /	Area 0.26	7 ft2	N. Sampling Tim	e	. 120 min	
H. Average Stack Ten	ıp 90.	0 deg F	O. Nozzle X-Sec	t Area	. 0.00053 ft	
I. Barometric Pressure	28.7	0 "HgA	P. Sample Collect	-tion	0.000033 1[
J. Gas Meter Pressure	(I+(D/13.6 28.8	6 "HaA	Q. Sample Colle	ction	0.172 mg	
K. Static Pressure		1 "H20	R. Water Vapor (Coodeneed		
L. Total Stack Pressur		7 "HgA	S. Gas Volume N	Netered	. 50.6 ml . 101.190 dcf	
T. Corrected Gas Volu	me [(S x J/29.92) x :	520/(460+B)	x C	********************	. 90.548 dscf	
PERCENT MOISTURE						
U. Percent Water Vap	or in Gas Sample ((4	1.64 x RV((0	0464 × P) + T)\		0.50.44	
			5 15 1 × 10, 1 1),	• • • • • • • • • • • • • • • • • • • •	. 2.53 %	
V. Average Molecular	Weight (Wet):					
Component	Vol. Fract.	x Mois	t. Fract. x	Molecular V	∨t. =	Wt./
Water	0.025	1.000	1	8.0	0.45	
Carbon Dioxide	0.000 Dry Basis			4.0 .		
Carbon Monoxide	0.000 Dry Basis			8.0	0.02	
Oxygen	0.209 Dry Basis			2.0	0.00	
Nitrogen & Inerts	0.791 Dry Basis			•	6.52	
		0.373	2	8.2	21.73	
·				Sum	28.72	
FLOW RATE						
W. Gas Density Corros	tion Factor (29 05 5	\^ E				
W. Gas Density Correct X. Velocity Pressure Co	errortion Footes (20.93/V	7			1.00	
X. Velocity Pressure Co	A rection ractor (29.	32/L)^.5			1.02	
Y. Corrected Velocity (A	``X V X VV X A)	•••••	•••••		28.18 fps	
Z. Flow Rate (Y x G x 6	-1) (7				452 cfm	
AA. Flow Rate (Standard	a) {Z x (L/29.92) x [5	20/(460+H)]]			409 scfm	
BB. Dry Flow Rate (AA)	k (U/100))	• • • • • • • • • • • • • • • • • • • •			399 dscfm	
SAMPLE CONCENTRA	TION/EMISSION RA	ATE				
CC. Sample Concentrati	on (0.01543 v /P/TV					_
DD. Sample Conc. [54,1	43yCC/ 59.7	(Malaassa-1	A & 17	***************************************	2.93E-05 gr/dscf	f
EE. Nickel Emission Pot		/woiecnist/	/ /t_)]	••••	0.02703 ppm	
EE. Nickel Emission Rat	- (0.0000) x pp xU				1.00E-04 lb/hr	
FF. Nickel Emission Rate	Pote (C + T + 422)	ا برها		••••••	1.00E-04 lb/hr	
GG. Isokinetic Sampling	nate [(G X 1 X 100).	(N X O X BB)]		94.9 %	

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Dates 9/3, 9/4, & 9/11/98

SOURCE TEST CALCULATIONS Flow Rate and Emissions for Run #3 with Air Agitation

Sample Train:	Nickel Train #1	5			ļ	nput by: M	Garibay		
SUMMARY A. Average Traverse B. Gas Meter Temper C. Gas Meter Correct D. Average Orifice Pr E. Nozzle Diameter	ature (Use 60 di ion Factor	eg.F for le	mp Com	p. Meters)	·····		26.42 87.6 1.0042 0.79 0.2500	deg F #H20	
F1. Stack Dimension F2. Stack Dimension G. Stack Cross Sect. H. Average Stack Tel I. Barometric Pressur J. Gas Meter Pressur K. Static Pressure L. Total Stack Pressu	#2 Area mp e (I+(D/13.6	7 inc inc 0.267 ft2 81.0 de 28.95 "Hi 29.01 "Hi -0.37 "Hi 28.92 "Hi	g F gA gA gA 20 gA	M. Pitot Corre N. Sampling O. Nozzle X- P. Sample Co Q. Sample C R. Water Var S. Gas Volur	Time Sect. Area. ollection ollection oor Conden ne Metered	sed	1.00 120 0.00034 0.0578 0.0578 33.5 62.388	ft mg mg ml dcf #	
T. Corrected Gas Vo	łume [(S x J/29.	92) x 520/(460+B) >	«.C		•••••••••••••••••••••••••••••••••••••••	57.679	dscf	
PERCENT MOISTUI	apor in Gas San	nple ((4.64	x R)/((0.	0464 x R) + T	·))		2.62	%	
V. Average Molecu		.). Fract. x	Mois	st Fract.	x M	lolecular W	t. =	W	t./
Water Carbon Dioxide Carbon Monoxide Oxygen Nitrogen & Inerts	0.026 0.000 Di 0.000 Di 0.209 Di 0.791 D	ry Basis ry Basis ry Basis	1.000 0.974 0.974 0.974 0.974		18.0 44.0 28.0 32.0 28.2	, , , , Sum	0.47 0.02 0.00 6.51 21.71		_
FLOW RATE W. Gas Density Co X. Velocity Pressur Y. Corrected Veloc Z. Flow Rate (Y x 0 AA. Flow Rate (Stal BB. Dry Flow Rate	e Correction Fa ity (A x M x W x 3 x 60)	ctor (29.92. x X) 9.92) x 1520	/L)^.5 D/(460+F	OT			43: 40:		
SAMPLE CONCEN CC. Sample Conce DD. Sample Conc. EE. Nickel Emissio FF. Nickel Emissio GG. Isokinetic Sam	ntration [0.0154 [54,143xCC/ n Rate (0.00857	3 x (P/T)] 58.7 (' x BB xCC	(Molecul:)	ar vvt.)]			0.0142 5.19E- 5.19E-	05 gr/dscf 6 ppm 05 lb/hr 05 lb/hr i.3 %	•



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Dates 9/3, 9/4, & 9/11/98

SOURCE TEST CALCULATIONS Emissions for Ambient with Air Agitation

Sample Train:	Nickel Train #7				input by	r: M.Gariba	v
SUMMARY A. Average Traverse V B. Gas Meter Temper C. Gas Meter Correcti D. Average Orifice Pre E. Nozzle Diameter	on Factoressure.	r for lemp C	omp. Mete	rs)		. 98.1 1.0023	fps 2 deg F
F1. Stack Dimension # F2. Stack Dimension # G. Stack Cross Sect. A H. Average Stack Terr J. Barometric Pressure J. Gas Meter Pressure K. Static Pressure L. Total Stack Pressure	f1 f2 Area pp	inch inch ft2 deg F 70 "HgA 87 "HgA "H20 "HgA	M. Pitot N. Samp O. Nozzi P. Samp Q. Samp R. Water S. Gas V	Correction I fing Time e X-Sect. A le Collection le Collection Vapor Con folume Mete	Factorreanndensedered	510 . 0.0084 0.0084 120.1 . 431.413	min ft mg mg ml
T. Corrected Gas Volu		: 520/(460+B	x C	***************************************		388.715	dscf
U. Percent Water Vapo V. Average Molecular	or in Gas Sample (Weight (Wet):		1.0464 x R)	+ T))	······	1.41	%
Component	Vol. Fract	t. x Moi	st. Fract.	×	Molecular V	√t. =	Wt./
Water Carbon Dioxide Carbon Monoxide Oxygen Nitrogen & Inerts	0.014 0.000 Dry Bas 0.000 Dry Bas 0.209 Dry Bas 0.791 Dry Basi	is 0.986 is 0.986		18.0 44.0 28.0 32.0 28.2	, , ,	0.25 0.02 0.00 6.59 21.98	
FLOW RATE							
W. Gas Density Correct X. Velocity Pressure Co Y. Corrected Velocity (A Z. Flow Rate (Y x G x 6 AA. Flow Rate (Standard BB. Dry Flow Rate (AA x	1 x M x W x X) 0) 1) {Z x (L/29.92) x I	.92/L)^.5 		••••••••••••••••••••••	•••••••••••••••••••••••••••••••••••••••	•	fps cfm scfm dscfm
SAMPLE CONCENTRAT							,
CC. Sample Concentration DD. Sample Conc. [54,14 EE. Nickel Emission Rate FF. Nickel Emission Rate GG. Isokinetic Sampling	9 (0.00857 x BB x 0	/ (Molecular CC) BB\/T1	Wt.)]		••••••		o/hr ppm

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Dates 9/3, 9/4, & 9/11/98

SOURCE TEST CALCULATIONS Flow Rate and Emissions for Run #1 No Air Agitation

Sample Train:	Nickel Train #4			. In	put by: M.	Garibay	
B. Gas Meter Tempe C. Gas Meter Correct	Velocityrature (Use 60 deg.F for tion Factorressure					26.32 fp 85.3 de 1.0042 1.99 "H 0.3168 in	eg F 120
F1. Stack Dimensior F2. Stack Dimensior G. Stack Cross Sect H. Average Stack To I. Barometric Pressu J. Gas Meter Pressu K. Static Pressure L. Total Stack Press	#2	deg F "HgA "HgA "H20 "HgA	M. Pitot Correction N. Sampling Time O. Nozzle X-Sect P. Sample Collect Q. Sample Collect R. Water Vapor Collect S. Gas Volume M	Area tion ction Condens	ed	1.00 120 m 0.00055 ft 0.0041 m 0.0041 m 45.9 n 99.153 d	ng ng nl lof
	olume [(S x J/29.92) x 52	0/(460+8)	x 0		*************		
U. Percent Water \ V. Average Molec	/apor in Gas Sample ((4.	64 x R)/((0).0464 x R) + T))			2.25	%
Component	Vol. Fract.	x Moi	ist. Fract. ×	Mc	olecular Wi	t. = 	Wt./
Water Carbon Dioxide Carbon Monoxide Oxygen Nitrogen & Inerts	0.023 0.000 Dry Basis 0.000 Dry Basis 0.209 Dry Basis 0.791 Dry Basis	0.97 0.97	7 7 7	18.0 44.0 28.0 32.0 28.2	Sum	0.41 0.02 0.00 6.54 21.79	
X. Velocity Presso Y. Corrected Velo Z. Flow Rate (Y x AA. Flow Rate (St BB. Dry Flow Rate	orrection Factor (28.95A) tre Correction Factor (29 city (A x M x W x X) G x 60) andard) {Z x (L/29.92) x (AA x (L/100))	[520/(460+	HVII			26.86 431 400	fps cfm scfm dscfm
CC. Sample Cond DD. Sample Cond EE. Nickel Emissi	NTRATION/EMISSION F entration [0.01543 x (P/I to [54,143xCC/ 58] on Rate (0.00857 x BB x on Rate [(.0001322 x Q x mpling Rate [(G x T x 10	[)] 1.7 (Molecu :CC)	2161 ****./2		**********	2.29E-06 2.29E-06	ppm 3 lb/hr

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Dates 9/3, 9/4, & 9/11/98

SOURCE TEST CALCULATIONS Flow Rate and Emissions for Run #2 No Air Agitation

Sample Train:	Nickel Train	#12				Input by	: M.Garib	ay	
SUMMARY									
	Volonitu								
A. Average Traverse B. Gas Meter Tempe	rature (ilea 60						25.9	7 fps	
B. Gas Meter Tempe	ialuie (USe 60 Fon Fontos	deg.r m	or Temp C	omp. Meter	rs)		. 94	.6 deg	F
C. Gas Meter Correct	oon Factor	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •				1.002	3	
D. Michage Office P.	C35016							8 "H20	ם
L. NOZZIE Diameter	***************	• • • • • • • • • • • • • • • • • • • •	······································	• • • • • • • • • • • • • • • • • • • •				5 inch	
F1. Stack Dimension	#1	7	' inch						
F2. Stack Dimension	#2		inch	M. Pitot	Correction F	actor	. 1.0	n	
G. Stack Cross Sect.	Area	0.267		N. Samp	ling Time		12	0 min	
H. Average Stack Ter	np	90.1	deg F	O. Nozzl	e X-Sect. A	rea	0.0005		
I. Barometric Pressure	3	28.85	"HgA	P. Samp	le Collection	٦	-	34 mg	
J. Gas Meter Pressure	∍ (I+(D/13.6	29.00	"HgA	Q. Samp	le Collectio	n		i4 ma	
-K. Static Pressure	***************************************	-0.40	"H20	R. Water	Vapor Con	densed	32	3 ml	
L. Total Stack Pressu	re (i+(K/13.	28.82	"HgA	S. Gas V	olume Mete	red	95.502		
T. Corrected Gas Volu	ıme [(S x J/29.	.92) x 52	20/(460+B)	x C	***************************************		86.999	dscf	
PERCENT MOISTUR									
U. Percent Water Var	or in Gas San	npie ((4.)	64 x R <i>VIII</i> 0	10464 v R)	+ T\\		4.00		
					• • //		1.69	1 %	
V. Average Molecula	r Weight (Wet)):							
Component	Vol.	Fract.	x Moi	st Fract	x	Molecular W	/t. =		Wt./
Water	0.017		1.000	·-··	18.0		0.20		
Carbon Dioxide	0.000 Dry	/ Basis	0.983		44.0	•	0.30		
Carbon Monoxide	0.000 Dry		0.983		28.0	•	0.02		
Oxygen	0.209 Dry	/ Basis	0.983		32.0	,	0.00		
Nitrogen & Inerts	0.791 Dry		0.983			•	6.57		
			5.000		28,2	•	21.92		
						Sum	28.81		
EL DIAL BATE							· · · · · · · · · · · · · · · · · · ·	·	
FLOW RATE									
W. Gas Density Correct X. Velocity Pressure C	ction Factor (2)	8.95 / √\^	5				4.00		
resourt resourte C	onecuon racio	or 179 97	71 10 5				1.00		
concered selectfy (M X IVI X VV X X	.)					1.02		
- CONTINUE (1 X G X)	OU)						26.52		
AA. Flow Rate (Standar	d) {Z x (L/29.9	2) x [52	7/(460+H)	······	• • • • • • • • • • • • • • • • • • • •			cfm	
BB. Dry Flow Rate (AA	x (U/100))	-, <u>[</u>		····	***************			scfm	
SAMPLE CONCENTRA				***************************************		******************	361	dscfm	
CC. Sample Concentrat	ion (0.01543 x	(P/T)]	•	•••••	•••••	*************	1.30E-05	ar/dscf	:
- 4. Campie Collic. 134. I	43XUU/	58 / (I	Molecutor	1.K/+ \1				-	
EE. Nickel Emission Ra FF. Nickel Emission Rai	te (0.00857 x E	38 YI I 🗀					4.25F-05	lb/br	
							4.25E-05	lh/hr	
GG. Isokinetic Sampling	Rate [(G x T	x 100)/(1	1 x O x BE	5)]			95.6		

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Dates 9/3, 9/4, & 9/11/98

SOURCE TEST CALCULATIONS Flow Rate and Emissions for Run #3 No Air Agitation

Sample Train:	Nickel Train #10			Input by:	M.Garibay
B. Gas Meter Tempe C. Gas Meter Correct	Velocity rature (Use 60 deg.F for T ion Factor ressure				1.0023 2.31 "H20
	#2	nch M. t2 N. teg F O. HgA P. HgA Q. H2O R. HgA S.	Sampling Time Nozzle X-Sect Sample Collect Sample Collect Water Vapor (Gas Volume M	n Factor	120 min 0.00055 ft 0.0634 mg 0.0634 mg 26.2 mi 100.637 def
U. Percent Water V. Average Molec	apor in Gas Sample ((4.6	34 x R)/((0.04€	54 x R) + T))		1.32 %
Component	Vol. Fract.	x Moist. F	ract. x	Molecular	- Wt. = Wt./
Water Carbon Dioxide Carbon Monoxide Oxygen Nitrogen & Inerts	0.013 0.000 Dry Basis 0.000 Dry Basis 0.209 Dry Basis 0.791 Dry Basis	1.000 0.987 0.987 0.987 0.987		18.0 , 44.0 , 28.0 , 32.0 , 28.2 , Sum	0.24 0.02 0.00 6.60 22.00 28.86
X. Velocity Pressi Y. Corrected Velo Z. Flow Rate (Y x AA. Flow Rate (St BB. Dry Flow Rate SAMPLE CONCE	orrection Factor (28.95/V) ure Correction Factor (29. city (A x M x W x X) G x 60) andard) {Z x (L/29.92) x [e (AA x (L/100)) NTRATION/EMISSION F	520/(460+H)]] ATE			26.82 fps 430 cfm 393 scfm 388 dscfm
DD, Sample Cond EE, Nickel Emiss	entration [0.01543 x (P/T : [54,143xCC/ 58 on Rate (0.00857 x BB x on Rate [(.0001322 x Q x mpling Rate [(G x T x 10	CC)			3.57E-05 lb/hr 3.57E-05 lb/hr



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Dates 9/3, 9/4, & 9/11/98

SOURCE TEST CALCULATIONS Emissions for Ambient No Air Agitation

Sample Train:	Nickel Train #13			Input by:	M.Garibay	
SUMMARY					- ····- ,	
	e Velocity					
B. Gas Meter Temp	erature (Use 60 deg.F f	or Tamp Ca		••••••••••	1	fps
C. Gas Meter Corre	ction Factor	or remp Co	mp. Meters)	••••••	96.5	deg F
D. Average Orifice F	Pressure	****************		•		
E. Nozzle Diameter.	***************************************			······	2.50 *	'H20
					i	inch
F1. Stack Dimension	າ #1	inch				
F2. Stack Dimension	າ #2	inch	M. Pitot Correction	n Factor		
G. Stack Cross Sect	. Агеа	ft2	N. Sampling Time		265	
H. Average Stack Te		deg F	O. Nozzie X-Sect	Area	255 r	
I. Barometric Pressu	re 28.85	"HgA	P. Sample Collec	tion	-	t
J. Gas Meter Pressu	re (I+(D/13.6 29.03	"HgA	Q. Sample Collec	tion	0.005 n 0.005 n	
K. Static Pressure	*************	"H20	R. Water Vapor C	ondensed	25.4 n	
L. Total Stack Pressu	ure (1+(K/13,	"HgA	S. Gas Volume M	etered	231.455 d	
T. Competed Co. 34						
r. Corrected Gas Vo	lume [(S x J/29.92) x 52	20/(460+B) :	« C	*******************	210.750 d	le~f
PERCENT MOISTUR						
U. Percent Water Va	por in Gas Sample ((4.	64 v D\//0	3464 53 733			
	per mi dad dampio ((4.	••• x 1√y((U.))404 X K) + 1)}		0.56 %	ó
V. Average Molecula	ar Weight (Wet):					
Component	Vol. Fract.	x Moist	Fract. x	Molecular Wt	L =	Wt./
Water	0.006	1.000				
Carbon Dioxide	0.000 Dry Basis	0.994		3.0	0.10	
Carbon Monoxide	0.000 Dry Basis	0.994		1.0	0.02	
Oxygen	0.209 Dry Basis	0.994		3.0	0.00	
Nitrogen & Inerts	0.791 Dry Basis	0.994		2.0	6.65	
		0.007	28		22.17	
				Sum	28.94	
FLOW RATE					- 	
W/ Goo Density Co						
X Velocity Pressure C	ection Factor (28.95/V)^	.5			1.00	
					fps	
					cfn	n
AA. Flow Rate (Standa BB. Dry Flow Rate (AA	'4) (4 X (1)23.32) X [52) X (1)/100\\	U/(46U+H)]}.			scf	m
BB. Dry Flow Rate (AA	x (0//00/)	****************	······································	·····	dsc	of m
SAMPLE CONCENTRA	ATION/EMISSION RAT	Έ				
CC. Sample Concentra	tion (0.01543 × /P/TV)					
					.66E-07 gr/d	dscf
EE. Nickel Emission Ra	te (0.00857 x BB xCC)		/t.)]).00034 ppn	
					lb/h	
GG. Isokinetic Sampling	Rate [(G x T x 100)	/ x O x BB/	······	••••••	lb/h	ır
,		×),		••••••	%	

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Dates 9/3, 9/4, & 9/11/98

SOURCE TEST CALCULATIONS **Unit Conversions**

54	lb/hr	lb/hr-ft2 tank	lb/hr-ft2 parts	lb/hr-cfmair	ar/dscf	mg/dscm	mg/hr	amperes	mg/A-hr
Run#			1.42E-05	6.33E-06	2.60E-05	5.95E-02	37	142	0.264
1 air	8.26E-05	5.51E-06		7.66E-06	2.93E-05	6.70E-02	45	142	0.319
2 air	1.00E-04	6.67E-06	1.72E-05			3.55E-02	24	138	0.171
3 air	5.19E-05	3.46E-06	8.92E-06	.3.89E-06	1.55E-05		35	141	0.251
Average	7.82E-05	5.21E-06	1.34E-05	5.96E-06	2.36E-05				
Ambient	N/A	N/A	N/A	N/A	3.33E-07	7.62E-04	N/A	N/A	N/A
1 no air	2.29E-06	1.53E-07	3.93E-07	6.30E-04	6.85E-07	1.57E-03	1	138	0.008
			7.30E-06	1.20E-02	1.30E-05	2.97E-02	19	135	0.143
2 no air	4.25E-05		6.12E-06	9.10E-03	1.07E-05		16	134	0.121
3 no air	3.56E-05				8.13E-06	 	12	136	0.090
Average	2.68E-05	1.79E-06	4.60E-06	7.25E-03			NA	N/A	NA
Ambient	N/A	N/A	N/A	N/A	3.66E-07	8.38E-04	INA	147	1 147

Where:

Surface Area of Tank Solution =

15 ft2

Surface Area of Parts =

5.82 ft2

Air Agitaion Rate Run #1 =

0.87 cfm/ft2tank

Air Agitaion Rate Run #2 =

0.87 cfm/ft2tank

Air Agitaion Rate Run #3 =

0,89 cfm/ft2tank

lb/hr is from the Flow Rate and Mass Emission Rate Spreadsheet

lb/hr-ft2 tank = lb/hr / Surface Area of Tank Solution

lb/hr-ft2 parts = ib/hr / Surface Area of Parts

lb/hr-cfmair = lb/hr-ft2tank / Air Agitation Rate per ft2tank

ppm is from the Flow Rate and Mass Emission Rate Spreadsheet

gr/dscf is from the Flow Rate and Mass Emission Rate Spreadsheet

mg/dscm = gr/dscf*2288.3

 $mg/hr = lb/hr \times 453592$

amperes is the average plating amperage from the facility's ammeter (no totalizing amp-hr meter)

mg/A-hr = mg/hr / average plating amperage during testing period

-43-

Dates 9/3, 9/4, & 9/11/98

APPENDIX

Field Data, Calibration Data, and Laboratory Results

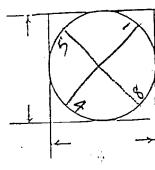
SOUTH COAST AIR QUALITY HAMAGEMENT DISTRICT

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SOUTH COAST AIR QUALITY HANAGEMENT DISTRICT

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SOUTH COAST AIR QUALITY HANAGEMENT DESTRICT Trat No. 98-189 Sample Train Sampling Location: -TRAVERSE SOURCE TEST DATA Post-Test Lesk Check: Pro-Test Leak Checki K=0.587 Filter ____cim @ __ Filter ____cfm @ ____"Hg vac Probe Ocon cin @ 2 "llg vac Proble 0.000 clm @ 15 "118 vac (Pitot Tube Leak Check (Filot Tube Leak Check Probe Filter Heter Temp Vacuum Calculated serre Gas Heler Stack "Hq Time retat Reading Velocity Sampling Orliler temp. Hemp. Velocity Temp. ULL Rate . °F On ۳F (Jul Head (lbw) (dc1) " ("1120) °F (c[=) ("B₂O) 310.627 5:490 Q-71 29-24 C. H71 318-3 0-14 27.00 0.503 82 0-16 320-1 28-64 0-553 0-18 934.6 25.24 C. A71 0.14 25.21 0.471 0.12 0.14 27.810.519 6.87 81 0.17 +30 26.98 0.504 0.8 +15 25.210-471 0.73 460 (Net Vol. Uncorr.) 62.388 AVE. 81.0 26:142 6.79 Nozzle 1 · min (6.25@ ") Recorded By____ Pilot Factor...../va Nozzle Diameter Barometric Pressure 28.95 '11₂0) "118,1 (+1<u>0.0.37</u> Statle Pressure in Stack Calibration Data Inclined Manometer ASD 115 (Cal: N/A Magnehelic No. N/A (Cal: Pitot Tube No. NIST TACEAGIS (Cal: 570) Potentiometer No. 20304 (Cal: 7/31/98



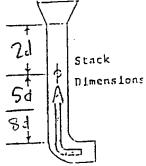
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Thermocouple No. 20113

Gas Heter No. No. 7/5

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SOUTH COAST AIR QUALITY HANAGEMENT DISTRICT

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SOUTH COAST AIR QUALITY HANAGEHERT BUSTRICT

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SOUTH COAST AIR QUALITY HAMAGEMENT DISTRICT

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<u> </u>		255.8	0.14		29.28	0.756	1.79			35+ 90	80	3000		
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+30		701.0	0.16	83	27.03	0.807 0.808	2.11					3		
+60		309.339	0.17	83	27.76	0.833	2.27			75	87	3, (3) m		
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Static Press	ure In	Stack	• • • • • • • •		P (tot Faci	tor	"H _E ,	۱ (+ <i>(</i> -)		<u>(-0)</u> (40 '	1120)		
		ation Data							ζ.	·		-		
Inclined Man Magneholic No.	١.	NIN (1	Jal:		-) -			$\overline{\lambda}$						
Pitot Tube Ho Potentiometer	No. 5		ial : <u>57!</u> ial : <i>7/\$/</i>		_김	(h		/ /	2		İ			
Thermocouple	No. 20	2113 (0	ה <u>ל ירי.</u> הלילה: הו		-;{)		_ 6	Stack			
Gas Heter No. Jeter Corr. F	<u></u>)719 (C	al: <u>12/</u>	52/95	_)			⁴ 5/	Så		nom1G	slons		
meer Garr. F	actor:	1.00	117	, ,			4	<u> </u>	81	- [][]				
ps Sampling 1	rabe_		2/055		-					[][(
			<u>, </u>					1		(1)				

SOUTH COAST AIR QUALITY HANAGEMENT DISTRICT

Total	· Na. (98-1	// /)	<i>i</i>	1/) /				11177			
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Grint	* i 3 () P = 10.			TRAUET	SE SOU	RCE TES	DATA						
			1					Post	-Test	Leak Chi	eck:		
Tre-	Test L	eak (.II	eck! @"I	ta var	K	=0.55	.2_	F110	er	cf= (?	_"Ilg v	ac
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Prol	ie DV	<u>∵</u> c[m	e <u>15</u> "	ng vac	_					e i.eak (
ווין)	ot Tub	e 1.enk	Check	,		w#I	}	•					-
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	+30	3	979.5	0.18	47	12.89	11.828	2.54		ļ	94	90 90	14
	+60	4	991.9	0.16	90	27.20	0.781	2.27		ļ	78	90	
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7	+15	5	1003.4	0.13	77	24.50	0.705	7.50				945	10
	+30	_6_	1015.6	0.15	90	24.34	0.756	2.17			103	45	10
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Barono	etric i	ressu	re <u>28.85</u> n Stack		'''	5'' ' 			FF:	и _я л (+	<u>(-) </u>	-4O	<u>''1120)</u>
Statio	c trans		ration Da	 ta		• • • • • • • • • • • • • • • • • • • •					·	7	
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	iter No			(Cal: <u>/</u>	7/3//	78)	<u> </u>		Cd3/	4	54	<u> </u>	
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Sáir	ap Hog	locati	lon:	01/16	3ch +	10-111	<u>G</u>	San	ple Tr	ılı #	 	-	 · · ·
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(0C1)		- '											
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On	Juic	1		Velocity Head	Temp.	Velocit	Sampling	Driller	temp.	Temp.			"Hg
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7-7-7	+15		Im. 9	0.11	ጵዎ	22.54	0.666	1.48			102	96	in
		6	114.2	0.16	89	27-18	0.803	2.44			100	96	15
			140-502	0.16	35	27.08	0.806	2.46			102	96	
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ornario	meter	NO. <u>W</u>	0504 (0	Cal: <i>7/9</i>	3/98	_{}			1	+	الما ا	Stack	
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SOUTH COAST AIR QUALITY HARAGEMENT DISTRICT

Test No. 90-109 Sampling Location: CALIF TEST PLATING Sample Train Am 5 TRAVERSE SOURCE TEST DATA Pro-Test Leak Check: Filter of a g "Ng vac Frohe 6000 cfm e /5 "Ng vac (Filot Tube Leak Check) Sample Train Am 5 Fort-Test Leak Check: Filter of a g "Ng vac (Filot Tube Leak Check)	
Pro-Test Leak Check: Filter cfm @ "Ilg vac Probe @ 0.00 cfm @ 15 "Ilg vac (Filot Tube Leak Check	
Pro-Test Leak Check: Filter cfm @ "Ilg vac Probe @ 0.00 cfm @ 15 "Ilg vac (Filot Tube Leak Check	_
Filter cfm @ "Ilg vac Filter cfm @ "Ilg vac Probe @ 0.00 cfm @ 15 "Ilg vac (Filot Tube Leak Check) Sample Gas Meter Stack Calculated Probe Filter Meter lemp Vac	
Filter	
(Pilot Tube Leak Check) Colourated Probe Filter Heter lemp Value Probe Prob	
(Filet Tube Leak Check) Asserte Gas Meter Stack Calculated Probe Filter Meter lemp Value Calculated Probe Filter Calculated Probe Filter Calculated Probe Filter Calculated Probe Filter Calculated Calculated Probe Filter Calculated C	
Assect Stack Calculated Probe Filter Meter lemp Va	
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(cfm) (cfm)	
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$\frac{-3c}{445}$ $\frac{468}{1200}$ $\frac{468}{1200}$ $\frac{2.5}{25}$ $\frac{98}{5}$ $\frac{87}{5}$ $\frac{5}{5}$	
+1,0 2,7 101 20 2	
+ 100	
+96 458.3	
105 472.0 7.4 75 8 1320 7.4 7.5 7	
1126 4 55.7 1 35 4 4 9 4 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	- "
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-195 9.6 104 9.7	<u> </u>
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96.5	
(Net Vol. Uncorn) 231.455 Avg. 2.5	
Nozzle / Recorded By E. T. Recorded By	
FOREIG Diameter	
Barometric Pressure HgA Picot Faces	1120)
Static Pressure in Stack	
Calibration Data	
Inclined Manometer (Cal: N/A)	
Magnehette No. (Cal:)	
Potentiometer No. Mo. Mo. Mo. Mo. Mo. Mo. Mo. Mo. Mo. M	
Thermographic No. (Cal:)	slon
Gas Hoter No. N. 7.715 (Cal: 7-30-95)	
Meter Corr. Factor: 1.0042	
Type Sampling Probe Californ	

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Test No. 98-109

Sampling Location DUCT OUTLET - CAPTURE HOOD

DATA SHEET FOR VERIFICATION OF CYCLONIC FLOW

Pretest Velocity Leak Check_ Post Test Velocity Leak Check

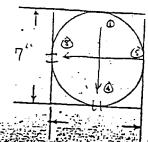
Time		Reference	Null Point Rotation Angle (± α)	Comments
	3 4	0·14 0·16 0·14 0·21	+8 0	Upper Poris
	5 6	0.14	0 +10	
	7	0.20	† 7 † 10 †5	
	1 2	0.17	0	
	3 4	0·17 0·19 0·13	† 7 †10 †5	Lower Ports
	5 6 . 7	0.13	+5 +5	
	8	0.15	0	
1				

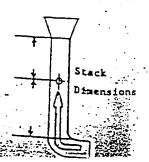
Recorded By On

Average Absolute Values of α ___

Calibration Data

Inclined Manometer_ Inclined Manometer (Cal: N/A)
Magnehelic No. 40412 (Cal: 515/58)
Pitot Tube No. 40412 (Cal: 7/3/17)





SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DATA SHEET FOR THERMOCOUPLE - POTENTIOMETER CALIBRATION

9-18-6 Semi annual Bi Monthly Calibration for Date Calibration by Other 340 26309 Temperature Source : Field Meter Reference STOC # :

COMMENTS O 507 ch#2 0 Δ°F : (B-A 0 Lead Wire STQC # : ch#1 0 \mathcal{C} 3/0 3(0 ch∦2 <u>+</u> A 121 ch#1 270 411 7 K 70 Temp. 40 0 Ref. Ċ 40114 20110 40113 30110 40114 30110 20113 Sensor 40114 STQC # C. 4011 Temp. 101 2011 1102 COMMENTS ch#2 5020 $\Delta^{\circ} F = (B-A)$ O 0 Ó ch∦1 Ð **#**== ch#2 010 3 Lead Wire STQC 7 r かり 5(0 ch#1 4 7. 3 1 4.0 20 0 Temp. Ref. 30110 20113 20113 40114 140113 40114 40114 Sensor STQC # 20113 30((0 401(3 4011 Jas II

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SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DATA SHEET FOR THERMOCOUPLE - POTENTIOMETER CALIBRATION

A CONTRACTOR OF THE PROPERTY O

Semi annual Bi Monthly_ Other Date Calibration by Calibration for Lead Wire STOC # : N0314 Temperature Source : Field Meter : STQC # : Reference : STQC # :

(VO 3 5 Other Lead Wire STOC # . (O)	Temp. A B $\Delta^{o}F =$ Sensor Ref. $Ch#1$ $Ch#2$ $Ch#3$ $Ch#4$	26/13/2/2/2/2/2/41 Ch#2 COMMENTS	14 212 212	410 411	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	0,212,		0 7/1/4/1/	
Lead Wire STOC # :	r Ref. Ch#1 Temp.	212 213 +1	212 214 +2	1+ 11h 0h)		715	0 712 717		

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DRY GAS METER COEFFICIENT CALCULATIONS

CALIBRATION PERIOD:

SEMIANNUAL OTHER

PERFORMED BY: DATE: 7-31-93 _ in Hg 90 BAROMETRIC PRESSURE (P bar) AMBIENT TEMPERATURE

1.) For non temperature compensated dry gas meters: Pbar + 13.6 29.92 $Q'_{std} := Q_{std} \left(\frac{520}{460 + \overline{1}} \right) \left(\frac{1}{460 + \overline{1}} \right)$ Corrected Flow Rate Q'std (scfm)

(in H₂0)

Temperature T (°F).

Flow Rate Q_{std} (cfm)

Pressure

Average Meter

Approximate Flow Rate 0 (cfm)

Standard Dry Gas Meter ID# 78

2.) For lemperature compensated dry gas meters: / $_{L}$ Pbar + 13.6 $o'_{ds} = o_{ds}$

29.92

3.) $Y_{ds} = Q'_{std}$

10n 0.9 * & ** The computed values in these columns must fall within the ranges indicated in their respective column headings.

3/4

1/2

1/4

<u>ء</u> ک	*** The computed values in this column must be greater that and less than 1.02, i.e., 0.98 < $\left(\frac{7}{V_{ds}} \div \frac{\pi}{V_{ds}}\right)$ < 1.02 ·
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,	- -				•														•			
	27001 = 1 000 5	201		ds	sp. ≻			•														
	Overall Ava	5.6	Averdge	Coefficient	1>														•			
			* 2	(1 ds max	Y ds min)	2,2,2,1							, J.								•	
			*	Coefficient	Y ds <	(CO:O = 7+1)	7 (%) .	1100	٦	600	41117	1.0032	707	1000	-9991	ンプロット	1000	1 (00:	2461,-	かんしい・		0) 1: 5:
				Corrected	Flow Rate Q'(scfm)	60																
		100 C		Meter	Pressure	p (iin m ₂ V)								-								
		Cald Day Cos Welse ID#	in more en	Average	Temperature	(4) I	•															
		ייים אוריני	rield DIY S		Flow Rate T	ds (cill)																
_				Approximate	Flow Rate a (cfm)				4/1:				1/2	1			3/4	•			·	•

	AIR QUALITY MANAGEMENT DISTRICT T FOR DRY GAS METER CALIBRATION CALIBRATION FOR: SEMI ANNUAL MONTHLY OTHER	(Dry Gas Meter) Meter Time Elapse Flow Read. Min: Time: Rate CF Sec. Min. CFM 505.6 506.8 514.8 8.3001
	er described and described to the descri	Press. (in H ₂ 0) 1 In/out 25 c
	II STRICT	Temp. (°F)
	AGEMENT C	Flow Rate CFM
	SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DATA SHEET FOR DRY GAS METER CALIBRATION 1	S Meter Elapse Time: Min.
-	AIR QUAI	Time Min: Sec. O
	DATA SHEET ON THE PATA SHEET OF THE PATA SHEET O	wetor nead cr 4393 445.2 445.2 450.3
	SOU (S/N) (STQC) N	Press. (in H20) In/Out (.05)
	STANDARD IDENTIFICATION (S/N) (S/N) (DRY GAS METER IDENTIFICATION (S/N) DRY GAS METER IDENTIFICATION (STQC) BAROMETRIC PRESSURE (Pbar)	70 70 70 70 70 70 70 70 70 70 70 70 70 7
	TIFICAT IDENTIF IDENTIF ESSURE (Crit. Orif. Ap
;	STANDARD IDENTIFICATION (S/NDRY GAS METER IDENTIFICATION DRY GAS METER IDENTIFICATION BAROMETRIC PRESSURE (Par)	Start End Avg.or Iotal Start End Avg.or Total
	STAND/ DRY G/ DRY G/ BAROME	pprox. Total FM CF roject
,		pprox.

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'	Flow	CFM							,									
	Elapse Time:	Min.																
(Dry Gas Meter	Time Min:	- II		21 (1772)	71.00	2	100/10	C		2 10 m	<u> </u>	Ð	70 Cx 7	> -07.70>	0	6	11.53.19-	0
(Ory G	Meter Read.	t73 6	7 545	0 - 00	S 900	6100		" U)	212.0	200, C	0 972	7000	Q · 0 + < n -		1240.	2.555		5553
	Press. (in 11 ₂ 0)	III/our		10			6,	1	1	100	Λ.		2 .			1	2	
	Temp. (°F)	\レ	35.00	3			:					1				1		1
	Flow Rate					•												V
Meter	Elapse Time: Min	7)										٠						
Secondary Standard Dry Gas Meter	Time Min: Sec.			21.23,02	0		180812	0		19.5713	0		14:53.60	0		1 4121	0 6	
Standar	Metor Read CF	439.3	でくちも		675/14	45.0,3		450.4	45.50		8-54,	4,79,1	-	484.2	1005	+	X 692	y 651
Secondary	Press. In H ₂ 0) In/Out			(.05			(.05			30.	n.	1	74	/		3.4	1	1
	Temp. (°F) In/Out			70.			10			70			70			70		
crit. Orif.	ΔP In II ₂ 0									· ·								
		Start	End	Avg.or Iotal	Start	End	Total	Start	End	fota 1ºr	Start	End	Avg.pr fotaj	Start	pu	Avg.or Total	Start	Fnd
Total		:						-	•		 .					<u>- j-</u>	<u></u>	<u>) : : </u>
Approx. Total	Project	>	4	-							-	10/	7					

Flow Rate CFM Elapse Time: 85-18-6 5.05.68 8.49.68 12 3094 10.45.96 (Dry Gas Meter) 1777.51 0 0 0 0 0 CALIBRATION FOR Time Min: Sec. 0 SEMI ANNUAL ٠, 3 8.419 8.500 620.5 0 \$-509605.K 1,627. (595.0 620. CALIB. BY: 583.3 50 602. MONTHLY Meter Read. CF 583 79 OTHER DATE: 2.2 7 in H₂0) In/Out S S 70 0 10 O Temp. (°F) n/Out 10 SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DATA SHEET FOR DRY GAS METER CALIBRATION STANDARD IDENTIFICATION (S/N) 78/2472 F.l ow Ra te CFM Elapse Time: Min. Secondary Standard Dry Gas Meter 59.9 08-15-8 12,0130 (0.50.85 (2,16,59 7.04 -O O 0 Ò. Q Time Min: Sec. 9 0.125 5563 540,6 ø, \sim 518.6 <u>549.c</u> 533.4 525. 599 Metor Read. CF DRY GAS METER IDENTIFICATION (STQC) NOTIC 527. 540 527 0 <u>S</u> Press. In H₂0) In/Out 6.5 6.2 ہے ف DRY GAS METER IDENTIFICATION (S/N). 2 70 Temp. (°F) In/Out % 9 0 BAROMETRIC PRESSURE (P_{bar}) Crit. Orif. In H20 AMBIENT TEMPERATURE End Avg.or Total Avg.pr Avg.or Total fota or Start Start Avg.or Total Start Start Start Start End End End End Approx. | Total CFM | CF

Project

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DRY GAS METER COEFFICIENT CALCULATIONS

CALIBRATION PERIOD: BIMONTHLY SEMIANNUAL AS- OTHER	1.) For non temperature compensated day and	Pbar + $\frac{p}{13.6}$ \rangle	29.92	ry gas meters:			ds ** The computed volumes in these solumes.	ranges indicated in their respective column headings.	in this column must be greater than 0.98	$\frac{1}{2}$	16-00-1 = 3	rds	SP_ =>	sp.									
	perature compensa	$Q'_{std} = Q_{std} \left(\frac{520}{460 + \overline{1}} \right) / P_{ba}$	t sp	\sim	ds bar 13.6		outed values in the	dicated in their re-	values 1.02,		Overall Aug	Ti	Coe	sp. , ds				-					
DATE: $2/30/9$ 8 PERFORMED BY: $11/3$	1.) For non tem			2.) FOF temperate	$sp_0 = sp_0$	3.). $Y_{ds} = Q'_{std}$	desperage of the company of the comp	ranges in	and less than			ent	<u> </u>	0077	1.0039	5003	10076	(1068	1.000.5	00 30	0.9992	_	· 11/95/12
in Hg D		Flow Rate	Die								7	Corrected	Q'scfm)										
2	er ID#	Pressure	7								No716	- 1	Pressure \overline{p} (in H ₂ 0)										
ا ڪ	Ury Gas Meter ID#	Temp T									Field Dry Gas Meter 10#.	Average Meter	emperature T (°F)										
BAROMETRIC PRESSURE (P bar) 29. AMBIENT TEMPERATURE	Standard Ury	Flow Rate Qstd (cfm)			,						Field Dry C		Q _{ds} (cfm)										
BAROMET	Approximate Flow Rate	. Q (cfm)	1/4		. 1/2	7),	+/6				Approximate	Flow Rate	(כוווו)	.1/4			1/2		3/4		-		

Flow Rate CFM Elapse Time: Min. \sim ij 1 2,02,40 452457 122,09.491 (3 09.2 (Dry Gas Meter) 70 72537 0 0 CALIBRATION FOR: 0 Time Min: Sec. 0 1 938.4 SEMI ANNUAL Q 5 CALIB. BY: 1901-7 326 720. MONTHLY 911 Meter Read. CF 88 4. 90/ -01384. OTHER 87 DATE: (in H₂0) In/Out Press 70 70 70 in/Out 70 70 (°F) STANDARD IDENTIFICATION (S/N) 78 1 DATA SHEET FOR DRY GAS METER CALIBRATION ٠, F1 ow Ra te CFN Elapse Time: Min. Secondary Standard Ory Gas Meter 2957 2) | 1638.68 \this 22 0 \bigcirc Q Time Min: Sec. O. 478.7 428.0 473 4 423.0 410.7 422.8 346 36/.6 31.8 1391.9 Meter Read. CF 402. 374. DRY GAS METER IDENTIFICATION (STQC) NO . 0 / 0 in H₂0) In/Out 6 9 S ٥ Press. 67 ģ DRY GAS METER IDENTIFICATION (S/N)_ .0 200 In/Out 2 0 (°F) 0 BAROMETRIC PRESSURE (Pbar) Crit. Orif. OP In H20 AMBIENT TEMPERATURE Avg.or Total Avg.Pr Avg.or Total Start Nota or Start Avg.or Total Start Start Start End **T** Start End End End End Total CF Approx. CFM Project V

CALIBRATION FOR: SEMI ANNUAL CALIB. BY: MONTHLY OTHER SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT DATA SHEET FOR DRY GAS METER CALIBRATION (S/N) 78.12470DRY GAS METER IDENTIFICATION (S/N) DRY GAS METER IDENTIFICATION (STQC)_ BAROMETRIC PRESSURE (P_{bar}). AMBIENT TEMPERATURE

	Se Flow Rate	7												-				
Meter)	Time Elapse Min: Time:			160181	21.7%		100	11.064/		9704.2.1	1. C. C.		17.57.01	2/-00		1071161	0	<u>-</u>
(Dry Gas Meter	Meter Ti Read. Mi CF	11	8048		804.9	010	9	4107			4780		7	X 0 0 0 0			84.6	8 +7 (
	Press. (in H ₂ 0) In/Out	10,0	1000	1				1			2.	Λ.		0			8	8
	Temp. (°F) In/Out			70			7.0			75			20			70		
	Flow Rate CFN				ي								,					-
ıs Meter	Elapse Time: Min.		 			. ·						•						
Standard Dry Gas Meter	Time Min: Sec.	Ō.		173/134			(8,59.26		<u> </u>	123651	0		12.41.70	0		12.193	\(\sigma\)	_
>	Meter Read. CF	289, G	2949		295.0	300.7		8.00%	7079		218.3	3.25.1		325.2	331.8		131-9	14701
Secondar	Press. In H ₂ 0) In/Out			1.2			1.2			7			2.3			3.3		\
1} [Temp. 0 (°F) In/Out			70			70			70			70			70		\ -
crit. Orif.	ΔP In H ₂ 0																	
		Start	End	Avg.or Intal	Start	End	Avg.or Total	Start	End	fota or	Stärt	End	Avg.pr	Start	End	Avg.or Total	Start	_
Total CF					•	:			.1								· · ·	=
Approx. Total SFM CF	Project	`	74										7.7					-

U.S. DEPARTMENT OF COMMERCE

NATIONAL INSTITUTE OF STANDARDS AND I ECHNOLOGY,

REPORT OF SPECIAL TEST

OF AIR SPEED INSTRUMENTATION

March 11, 1998

Two Pitot-Static Tubes

submitted by

South Coast Air Quality Management District
Applied Science & Technology
21865 E. Copley Drive.

Diamond Bar, CA 91765 4182

The calibration of the Pitot static tubes were performed in the 1 m (three-foot) by 1 m (three-foot) 41ST Low Velocity Airflow Facility. The instrument under test was supported near the center of the tunnel in a manner that presented negligible interference to the flow. The air speed was of the tunnel in a manner that presented negligible interference to the flow. The air speed was measured by the NIST laboratory standard laser velocimeter on the centerline of the tunnel, measured by the Pitot-static tubes. The air temperature, humidity, and atmospheric pressure were pressured inside the tunnel.

The calibration of the Pitot-static tube consists of determining the calibration factor, K, defined as the square root of the ratio of the air speed indicated by the instrument under test to the air speed indicated by the instrument under test to the air speed indicated by the NIST laboratory standard velocimeter. K may be a function of the Reynolds number, Re, which is expressed as

Re = Vd/v

where V is the air speed, d is the dinmeter of the Pitot-static tube, and v is the kinematic viscosity.

Two calibration cycles were done, separated by a shutdown. Each speed in each cycle is measured five times.

Report of Special Test
Test Date February 12, 1998

Page 1 of 5

2

REPORT OF SPECIAL TEST
South Coast Air Quality Mgmi. District

2 Pitot Static Tubes

Tables 1 and 2 and Figure 1 show the expanded uncertainty values for the NIST air speed calibration facilities. The data listed in the remaining tables are calculated from the means of the 10 measurements at each speed. Listed are the air speed measured by the NIST standard, K. Re. and the expanded uncertainty of the measurements for the instrument under test.

The expanded uncertainty of the measured values for the instrument under test, U, is given by

 $U = k \sqrt{u_i^2}$

where k is the coverage factor, taken to be 2, and the u are the contributions to the uncertainty from various sources. For this calibration, there are two sources of uncertainty: u is the standard deviation of the ten measurements at each speed, and u is one half the uncertainty at a given speed shown in Tables 1 and 2 and in Figure 1, which was obtained through the characterization of the MIST standards.

Fur the Director,

National Institute of Standards and Technology

Dr. George E. Maningly Leader, Fluid Flow Group

Tocess Measurements Division

Themical Science and Technology Laboratory

Report of Special Test
Test Date February 12, 1998

Page 2 of 5

N. E. Mease, W. G. Cleveland, Jr., G. E. Maringly, and J. M. Hall, "Amspeed Calibrations at the Nadonal Institute of Standards and Technology," Presendings of the 1992 Measurement Science Conference, Anahelm, CA,

^{*}A.N. Taylor and C.B. Kuyan, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results," NIST Technical Note 1297, National Institute of Standards and Technology, January 1993.

Expanded Uncertainties for NIST Air Speed Facilities

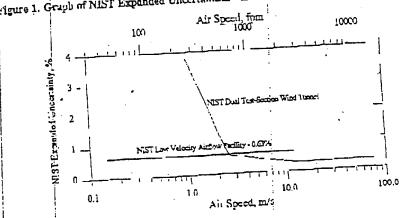
ed Uncertainty of the NIST Low Velocity Airflow Facility

Table 1. Expanded Uncertaint	y of the NIST LOW VICELY	
Table 1. Exp	Uncertainty, (%)	Air Speed, form
Air Speni, m/s	Uncertainty, (707	; un to 2200
	0.6	11/10/2200
up to 10	1	

Table 2. Expanded Uncertainty of the NIST Dual Test-Section Wind Tunnels

Table 2. Expanded Uncertainty	Uncertainty, %	Air Speed, fpm
Air Speed, m/s	3.8	200
1	13	400
2	0.6	600
3	0.45	1000
1 5	0.31	2000
10	0.28	3000 - 15000
15 - 75		

Figure 1. Graph of NIST Expanded Uncertainties - all facilities



Report of Special Test Test Date

February 12, 1998

Page 3 of 5

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SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT 21865 Copley Dr., Diamond Bar, CA 91765-4182

APPLIED SCIENCE AND TECHNOLOGY LABORATORY ANALYSIS REPORT

TO Mike (Source Monito	Mike Garibay, Engineer II Source Testing & Engineering	LABORATORY NO	9253808
	Monitoring & Analysis	REFERENCE NO	JSV-25-35
SAMPLE	Four Nickel Trains	SOURCE TEST NO	98-109
	One Reagent Blank	PREPARATION NO	9239804
SOURCE	California Technical Plating. Nickel Plating Tank 11533 Bradley St. San Fernando, CA	DATE RECEIVED	9/4/98

ANALYTICAL WORK PERFORMED, METHOD OF ANALYSIS, AND RESULTS Nickel by CARB Method 433

Equip Number(s) Sample point	5 source sample	14 source sample	15 source sample	7 composite ambient	
Moisture gain (loss), g Silica gel expended, percent Notes on train condition Total nickel, ug	56.3 85 (1) 153	50.6 90 (2) 172	33.5 50 (3) 57.8	120.1 >95 (4) 8.4	ASTD RECEIVED
Comments and deviations					OCT C

Comments and deviations:

OCT 0 5 1998

(1) Some graying over filter support holes.

(2) Very light graying over filter support holes.

S.T. & E. BRANCH

(3) No graying on filter.

(4) Substantial graying over filter support holes.

Samples were reported with reagent blank subtracted. Reagent blank was 1.2 ug total. Samples were analyzed by West Coast Analytical Services (WCAS) by ICP/MS. (see attached report)

Date Approved:

Approved By

Rudy Eden Senior Manager

Laboratory Services

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SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT 21865 Copley Dr., Diamond Bar, CA 91765-4182

APPLIED SCIENCE AND TECHNOLOGY LABORATORY ANALYSIS REPORT

TO Mil Mo Mo	Mike Garibay Engineer II	LABORATORY NO	9253807
	Mike Garibay, Engineer II Monitoring & Engineering Monitoring & Analysis	REFERENCE NO	JSV-25-35
	MOUNTAINE CO / Many 5-0	SOURCE TEST NO	98-110
SAMPL	E Two Nickel Trains One Reagent Blank	PREPARATION NO	9240807
SOURC	CE California Technical Plating. Nickel Plating Tank 11533 Bradley St. San Fernando, CA	DATE RECEIVED	9/6/98

ANALYTICAL WORK PERFORMED, METHOD OF ANALYSIS, AND RESULTS Nickel by CARB Method 433

Equip Number(s) Sample point	3 field blank	4 source sample	ASTD RECEIVED
Moisture gain (loss), g Silica gel expended, percent Notes on train condition Total nickel, ug	<0.1 <10 2.8	45.9 75 (1) 4.1	0CT 0 6 1998 S.T. & E. BRANCH

Comments and deviations:

(1) Filter was off-center.

Samples were reported with reagent blank subtracted. Reagent blank was 2.2 ug total. Samples were analyzed by West Coast Analytical Services (WCAS) by ICP/MS. (see attached report)

Date Approved: 9/29/98

Approved By: Rudy Eden, Senior Manager

Laboratory Services

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September 21, 1998

SCAQMD 21865 East Copley Drive Diamond Bar, CA 91765

Attn:

Joan Niertit

Job No: 39239

S

LABORATORY REPORT

Samples Received:

Eight (8) Liquids

Date Received:

09/10/98

Purchase Order No: 99107

The samples were analyzed as follows:

<u>Analysis</u>

Page

Nickel by ICPMS

2

Charles Jacks, Ph.D. Senior Staff Chemist

D.J. Northington, Ph.D. Quality Assurance Officer

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Page 1 of 2

9840 Alburtis Avenue • Santa Fe Springs, CA 90670 • 562-948-2225 • FAX 562-948-5850 • http://www.wcaslab.com

SCAQMD

Attn: Joan Niertit

Job No: 39239 September 21, 1998

LABORATORY REPORT

Nickel Quantitative Analysis Report Inductively Coupled Plasma-Mass Spectrometry

Parts Per Billion (ug/1)

Sample ID	Nickel
Reagent Blank 98-109 Train #5 Train #7 Train #14 Train #15	12 1540 96 1730 590
Reagent Blank 98-110 Train #4 Train #3	22 63 50
Detection Limit:	0.1

Date Analyzed: 9-14-98 & 9-16-98

Quality Control Summary

Sample: Train #4
Matrix: Liquid

Parts Per Billion (ug/l)

	Nickel
Sample:	63
Duplicate:	64
Average:	63.5
Sample RPD:	1.6
Spike Conc:	100
MS Result:	160
% Recovery	96.5

Date Analyzed: 9-14-98

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Page 2 of 2

WE'S

Abbreviations Summary

General Reporting Abbreviations:

- Blank Indicates that the compound was found in both the sample and the blank. The sample value is reported without blank subtraction. If the sample value is less than 10% the blank value times the sample dilution factor, the compound may be present as a laboratory contaminant.
- D Indicates that the sample was diluted, and consequently the surrogates were too dilute to accurately measure.
- DL Detection Limit Is the minimum value which we believe can be detected in the sample with a high degree of confidence, taking into account dilution factors and interferences. The reported detection limits are equal to or greater than Method Detection Limits (MDL) to allow for day to day and instrument to instrument variations in sensitivity.
- J Indicates that the value is an estimate.
- ND Not Detected Indicates that the compound was not found in the sample at or above the detection limit.
- ppm Parts per million (billion) in liquids is usually equivalent ppb to mg/l (ug/l), or in solids to mg/kg (ug/kg). In the gas phase it is equivalent to ul/l (ul/m^3).
- TR Trace Indicates that the compound was observed at a value less than our normal reported Detection Limit (DL), but we feel its presence may be important to you. These values are subject to large errors and low degrees of confidence.

kg kilogram mg milligram l liter m meter g gram ug microgram ul microliter

OC Abbreviations:

Control QC Limits are determined from historical data. The test value must be within the Control Limits for the test to be considered valid. Based on historical data, the confidence intervals are 95% for warning limits and 99% for control limits.

Percent Error - This is a measure of accuracy based on the analysis of a Laboratory Control Standard (LCS). An LCS is a reference sample of known value such as an NIST Standard Reference Material (SRM). The % Error is expressed in percent as the difference between the known value and the experimental value, divided by the known value. The LCS may simply be a solution based standard which confirms calibration (ICV or CCV - initial or continuing calibration verification), or it may be a reference sample taken through preparation and analysis.

Wie:R

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT 21865 Copley Dr., Diamond Bar, CA 91765-4182

MONITORING AND ANALYSIS LABORATORY ANALYSIS REPORT

то	ACL Coribay Engineer II	LABORATORY NO	925 8806
	Mike Garibay, Engineer II Source Testing & Engineering Monitoring & Analysis	REFERENCE NO	JSV-25-45
	Monitoring & Analysis	SOURCE TEST NO	98-111
SAMPLE Four Nickel Trains	Four Nickel Trains	PREPARATION NO	9240808
SOURC	One Reagent Blank E California Technical Plating Nickel Plating Tank 11533 Bradley St. San Fernando, CA	DATE RECEIVED	Sept. 15,1998

ANALYTICAL WORK PERFORMED, METHOD OF ANALYSIS, AND RESULTS Nickel by CARB Method 433

Equip Number(s) Sample point	6 field blank	10 source sample	12 source sample	18 composite ambient
Moisture gain (loss), g Silica gel expended, percent	0.2 <10	26.2 50	32.3 40 (1)	25.4 85 (2)
Notes on train condition Total nickel, ug	2.0	63.4	73.4	5.0

Comments and deviations:

(1) Very light graying over filter support holes.

(2) Light graying over filter support holes.

Samples were reported with reagent blank subtracted. Reagent blank was 1.6 ug total. Samples were analyzed by West Coast Analytical Services (WCAS) by ICP/MS. (see attached report WCAS Job No 39331)

Date Approved:

Approved By

Rudy Eden, Senior Manager

Laboratory Services

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September 28, 1998

SCAQMD 21865 East Copley Drive Diamond Bar, CA 91765

Attn:

Joan Niertit

Job No: 39331

D

LABORATORY REPORT

Samples Received:

Five (5) Liquids

Date Received: Purchase Order No: 99107

09/21/98

The samples were analyzed as follows:

<u>Analysis</u>

<u>Page</u>

Nickel by ICPMS

2

Charles Jacks, Ph.D. Senior Staff Chemist

Northington, Ph.D. Quality Assurance Officer

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SCAQMD Attn: Joan Niertit Job No: 39331

September 28, 1998

LABORATORY REPORT

Nickel Quantitative Analysis Report Inductively Coupled Plasma-Mass Spectrometry

Parts Per Billion (ug/l)

_	<u>Nickel</u>
Sample	16
98-111 Reag Blank	36
Train #6	650
Train #10	750
Train #12 Train #18	66
Detection Limit:	0.1

Date Analyzed: 9-24-98

Quality Control Summary

Sample: Train #18 Matrix: Liquid

Parts Per Billion (ug/l)

	<u>Nickel</u>
Sample:	66
Duplicate:	64
Average:	65
Sample RPD:	3.1
Spike Conc:	100
MS Result:	163
% Recovery	98

Date Analyzed: 9-24-98

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Page 2 of 2

WES

CALIFORNIA TECHNICAL PLATING, CORP. NICKEL NICKEL

SAN FERNANDO, CALIFORNIA 91340

(818) 365-8205

FAX (818) 365-4895

Tank #63

BATH CONTROL LOG

			CAPACITY	= 410	GALS. No.	-140 F	TEMP. We	ekly. commen
DATE OZ GAL OPERATING RANGE			÷E	ADDITIONS ADDITIONS				
1998	Ni 10-12	Ni CS+3NHJ) 42-50	Addi A1 .45-3.0	Boric Acid 4.5-7.0	SNAP-AM	3.5- 4.5	Filted Dummy	Addition
5.12	[0.11 9.90	4207	1.96	4.54	.31	3.8		Add 5 gar
519	10.40	4292	1.92	4.50	. 3 2	3.8	Filmed	1 N N M 1 4 4 C 2 N N - 1 A
5-28	10.37	43.86	1.90	4.58	.30	3.6		OK DIPT MP
6-2	10.26	43.60	1.86	4.68	.31	3.8	PAIN	our Ap
6-9	10.7	43.39	1.84	4.62	.30	3.6		and
6-16	9.95	42.28	1.89	4.66	.32	2.54	0/Film	6. FAAL JNR-24
<u>ز-۲۶</u>	10.10	42-90	1.90	4-67	- 3)	3.52	effired.	ous-
,~¥U	10.20	43.35	1.90	4.62	.3~	3.50		OF DIPT
7-7	10.18	43.76	1.91	4-60	٧٠.	3.52	Firme.	aleg
1-14	10.20	42.96	1.92	4.90	.31	3.51	माम्यः इति। मर्चः	10 1 Pt/10
1-21	10.11	42.96	1.90	4.91	.31	3.50		ars
-28	10.17	4522	1.91	4.96	· 31	7.5	ドル	dus
<u>- 4</u>	(0·70)	42.35	1.90	4.92	.32	3-10		068_
-17	10.15	it 3. 3°	1.89	4.90	.33	3. 50		Cle 2 542-24
.18	10.76	43.61	1.88	4.91	・3レ	3.52		den
8.4	10.10	42.92	1.91	4.90	(6.	2 · د	·	or Jupy of
3, 2	10.31	45.94	1.90	4.96	.32	3.5V		Ole XI
		17 14						

13744 MONTE VISTA AVENUE · CHINO, CALIFORNIA 91710 · (809) 627-3628 · FAX (909) 627-0491

USTOMERSOL	ITH COAST AQMD	WAL NO			
			DATE RECEIVED_	11/12/98	
TTENTIONJOH	N MCLAUGHLIN		DATE OF REPORT_	11/17/98	
AMPLE IDENTIFICATIO	NICKEL S	SULFATE PLATING SOLUTION			
		VIA TECHNICAL PLATING			
·	TANK NO.	GALLONS	SAMPLED	11/12/98	
ANALYSIS		STANDARD	RESULTS		
			on ise		
NICKEL			78.1	g/1	
VICKEL SULFATE			43.8 328	g/1	
NICKEL CHLORID	E		262 19.6	g/1	
ORIC ACID			7.60 56.9	g/1	
ρΗ			 2.01		
URFACE TENSION	٠ - ١		37.9	dyne/cm	